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OF
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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 10 FEBRUARY, 1917 No. 1

# Proceedings of the Twenty-Ninth Annual Meeting of the American Association of Economic Entomologists

The twenty-ninth annual meeting of the American Association of Economic Entomologists was held in the Teachers' College, Columbia University, New York City, December 28 to 30, 1916. The first session was held at 10 a. m., Thursday, December 28, when the annual reports of the officers of the Association were given. Owing to the illness of President Hewitt, his address was not delivered until Friday, December 29.

The meeting of the Section on Apiculture was held at 8 p. m., December 28, at the New York Museum of Natural History. The meeting of the Section on Horticultural Inspection was held at 2 p. m., December 29, at the Teachers' College at Columbia University and an evening session at the American Museum of Natural History.

The business proceedings of the Association are given as Part I of this report, and the addresses, papers, and discussions will be found in Part II. The proceedings of the sections will be prepared by the section secretaries and published as parts of this report.

The attendance was the largest of any meeting which has been held by the Association, and a very crowded and interesting program was given.

## PART I. BUSINESS PROCEEDINGS

The meeting was called to order by First Vice-President George A. Dean at 10.15 a. m., Thursday, December 28, 1916. About 200 members and visitors attended this session. The following members were present.

Ackerman, A. J., Washington, D. C.
Ainslie, George G., Knoxville, Tenn.
Allen, H. W., Melrose Highlands, Mass.
Atwood, George G., Albany, N. Y.
Back, E. A., Washington, D. C.
Backus, H. E., North East, Pa.
Bailey, I. L., Northboro, Mass.
Ball, E. D., Madison, Wis.
Becker, G. G., Fayetteville, Ark.
Bentley, G. M., Knoxville, Tenn.
Beutenmuller, Wm., Bronx, N. Y.
Beyer, A. H., Columbia, S. C.
Bilsing, S. W., College Station, Texas.
Blackman, M. W., Syracuse, N. Y.
Bradley, J.W., Melrose Highlands, Mass.
Britton, W. E., New Haven, Conn.
Burgess, A. F., Melrose Highlands, Mass.
Clapp, S. C., Raleigh, N. C.
Cockerell, T. D. A., Boulder, Colo.
Collins, C. W., Melrose Highlands, Mass.
Cook, Mel. T., New Brunswick, N. J.
Cooley, R. A., Bozeman, Mont.
Cory, E. N., College Park, Md.
Crampton, G. C., Amherst, Mass.
Crawford, J. C., Washington, D. C.
Crosby, C. R., Ithaca, N. Y.
Crossman, S. S., Melrose Highlands, Mass.
Culver, J. J., Melrose Highlands, Mass.
Davis, I. W., New Haven, Conn.
Davis, J. J., Lafayette, Ind.
Dean, George A., Manhattan, Kan.
Dickerson, E. L., Nutley, N. J.
Dohanian, S. M., Melrose Highlands, Mass.
Eddy, M. W., State College, Pa.
Engle, E. B., Harrisburg, Pa.
Felt, E. P., Albany, N. Y.
Fenton, F. A., W. Lafayette, Ind.
Fernald, H. T., Amherst, Mass.
Fink, D. E., Norfolk, Va.
Fiske, R. J., Washington, D. C.
Fulton, B. B., Geneva, N. Y.
Garman, Philip, College Park, Md.
Gates, B. N., Amherst, Mass.
Gates, F. H., Tempe, Ariz.
Gibson, E. H., Alexandria, Va.
Glasgow, Hugh, Geneva, N. Y.
Gossard, H. A., Wooster, Ohio.
Gram, Ernst, Ithaca, N. Y.
Hadley, Charles H., Jr., State College, Pa.
Harned, R. W., Agricultural College, Miss.
Hawley, I. M., Indianapolis, Ind.
Headlee, T. J., New Brunswick, N. J.
Hertzog, P. M., Hightstown, N. J.
Herrick, Glenn W., Ithaca, N. Y.
Hewitt, C. Gordon, Ottawa, Canada.
Hinds, W. E., Auburn, Ala.
Hine, J. S., Columbus, Ohio.
Hood, C. E., Melrose Highlands, Mass.
Hopkins, A. D., Washington, D. C.
Houser, J. S., Wooster, Ohio.
Howard, C. W., St. Paul, Minn.
Howard, L. O., Washington, D. C.
Howard, N. F., Madison, Wis.
Hungerford, H. B., Ithaca, N. Y.
Hyslop, J. A., Hagerstown, Md.
Jennings, A. H., Washington, D. C.
Jones, D. W., Melrose Highlands, Mass.
King, J. L., Cleveland, Ohio.
Kisliuk, Max, Jr., Washington, D. C.
Kelly, E. O. G., Wellington, Kan.
Kotinsky, J., Washington, D. C.
Lamson, G. H., Jr., Storrs, Conn.
Larrimer, W. H., Charleston, Mo.
Lathrop, F. H., Columbus, Ohio.
Leiby, R. W., Raleigh, N. C.
Leonard, M. D., Ithaca, N. Y.
Lowry, Q. S., New Haven, Conn.
Manter, J. A., Storrs, Conn.
Marcovitch, Simon, St. Paul, Minn.
Marlatt, C. L., Washington, D. C.
Martin, J. F., Amherst, Mass.
Maxon, Asa C., Longmont, Colo.
McColloch, J. W., Manhattan, Kan.
McDonough, F. L., Clarksville, Tenn.
McLaine, L. S., Ottawa, Canada.
Merrill, G. B., Gainesville, Fla.
Merrill, J. H., Manhattan, Kan.
Metcalf, Z. P., W. Raleigh, N. C.
Minott, C. W., Hudson, Mass.
Morrison, Harold, Washington, D. C.
Morse, A. P., Wellesley, Mass.
O'Kane, W. C., Durham, N. H.
Osborn, Herbert, Columbus, Ohio.
Osgood, W. A., Durham, N. H.
Parrott, P. J., Geneva, N. Y.
Patch, Edith M., Orono, Me.
Peterson, Alvah, New Brunswick, N. J.
Phillips, E. F., Washington, D. C.
Phillips, Saul, Beverly, Mass.
Phillips, W. J., Charlottesville, Va.

Plank, H. K., Washington, D. C.
Quaintance, A. L., Washington, D. C.
Rane, F. W., Boston, Mass.
Reeves, George I., Salt Lake City, Utah.
Regan, W. S., Amherst, Mass.
Richardson, C. H., New York City.
Riley, W. A., Ithaca, N. Y.
Rockwood, L. P., Forest Grove, Ore.
Rogers, D. M., Boston, Mass.
Sanders, J. G., Harrisburg, Pa.
Sanford, H. L., Washington, D. C.
Sasscer, E. R., Washington, D. C.
Satterthwait, A. F., Lafayette, Ind.
Scammell, H. B., Washington, D. C.
Schaffner, J. V., Jr., Dover, Mass.
Seigler, E. H., Washington, D. C.
Shaw, N. E., Columbus, Ohio.
Shelford, V. E., Urbana, Ill.
Sherman, Franklin, Jr., Raleigh, N. C.
Simanton, F. L., Washington, D. C.
Skinner, Henry, Philadelphia, Pa.
Smith, G. A., Boston, Mass.
Smith, H. E., W. Springfield, Mass.
Smulyan, M. T., Blacksburg, Va.
Stockwell, C. W., Melrose Highlands, Mass.
Tower, D. G., Washington, D. C.
Turner, W. F., Vienna, Va.
Viereck, H. L., Washington, D. C.
Wade, Joe S., Wellington, Kan.
Walden, B. H., New Haven, Conn.
Washburn, F. L., St. Anthony Park, Minn.
Webber, R. T., Melrose Highlands, Mass.
Webster, R. L., Ames, Iowa.
Weiss, H. B., New Brunswick, N. J.
Wheeler, W. M., Forest Hills, Mass.
Wolcott, G. N., Champaign, Ill.
Woods, W. C., Orono, Me.
Wooldridge, Reginald, Melrose Highlands, Mass.
Worsham, E. L., Atlanta, Ga.
Worthley, L. H., Melrose Highlands, Mass.
Zappe, Max P., New Haven, Conn.

VICE-PRESIDENT GEORGE A. DEAN: The meeting will please come to order. I am sorry to announce that Dr. Hewitt, President of the Association, is ill, but we hope he will be able to be present at a later session. The first business on the program is the report of the Secretary.

## REPORT OF THE SECRETARY

The total membership of the Association at the time of the last annual meeting was 454, divided as follows: active 135, associate 267, and foreign 52. At that meeting one active member resigned, one was transferred to associate membership; five associate members resigned and seven were transferred to active membership; and 31 associate members were elected.

During the year, three active members have died and three active and five associate members have been dropped from the rolls. The deaths have been announced of two foreign members, Andrew Rutherford and Prof. Sven Lampa. The membership at present is 466, consisting of active 134, associate 282, and foreign 50, a net gain for the year of 12.

During the last meeting, held at Columbus, members of the Association were greatly shocked to learn of the severe illness of Prof. F. M. Webster, who had been present at the early sessions. He was taken to the hospital at Columbus, Ohio, and died January 3, 1916. Professor Webster was one of the original members of the Association and was well known and highly respected by all entomologists. On March 23, 1916, Mr. Theodore Pergande, one of the pioneer members of the Bureau of Entomology, died at Washington, D. C., and on November 18, 1916, Mr. Otto Heidemann of the same Bureau died after a brief illness. These three men were among the oldest members of the Association. Their loss has been severely felt by the Bureau of Entomology and indirectly by the entomologists of this country.

The Pacific Slope Branch which came into existence through the action taken at the last annual meeting held its annual meeting August 9–10, 1916, at San Diego, California, in connection with the meetings of the Pacific Coast Branch of the American Association for the Advancement of Science. The report of the sessions was published in the October number of the JOURNAL and speaks for itself as to the success of the branch and as to the wisdom of its establishment. Mr. E. O. Essig, the secretary, has been very successful in handling the new branch and most pleasant relations exist between it and this Association.

The finances of the Association are in such a condition that the publication of the Index of American Economic Entomology can be undertaken if a reasonable number of advance subscriptions can be secured.

## THE JOURNAL OF ECONOMIC ENTOMOLOGY

The JOURNAL has had a satisfactory year although the financial balance is somewhat less than last year. The complete proceedings of the Columbus meeting were published in the February issue, but it was impossible to mail this number until March 4. This number contained 252 pages in addition to the list of officers, meetings and members which is published each year.

In spite of this fact, the other numbers during the year were not materially reduced in size; 580 pages were published in 1916 against 566 for the previous year. The number of illustrations appearing in the JOURNAL is increasing rapidly each year, which means additional cost both for their preparation and printing. Members are urged to submit only such illustrations as are vital to the proper understanding of the papers which they wish published. The JOURNAL management will sell to authors at cost the cuts prepared for illustrating their papers and it is hoped that many of these can be disposed of in this way, as it will supply more funds for improving the publication.

The cost of issuing the JOURNAL has increased during the past year. A contract has been signed for 1917 at a further advance. The price of paper and nearly everything that has to do with the publication has increased in price, and the expense next year will be approximately one-third greater than heretofore. The advertising in the JOURNAL has decreased slightly as the manager has not felt warranted in pushing an aggressive campaign to sell space. Most of our old advertisers have remained without being persistently solicited, which speaks well for the publication as an advertising medium.

The report last year showed that the net increase in the subscription list was 44, and although many foreign subscriptions were cancelled there was a net gain of three in that class of subscribers. As anticipated the record of the past year has been less favorable and the future does not look encouraging. Total subscriptions for 1916 show 11 less than the previous year. There was an increase in the United States but a loss of 21 foreign subscribers was responsible for the unfavorable showing. In all probability, we will have less foreign business during the coming year. This means one of three things: an increase in price of the publication, which is now selling much lower than others of the same grade and size; the publication of less matter; or more interest among the members in securing additional subscribers. It should be an easy matter to solve the problem in the latter way. During the past year, several members have done good work in this respect. A little more energy in securing one more subscription to the JOURNAL will solve the problem.

ASSOCIATION STATEMENT

| | | |
|---|---|---|
| Balance in Treasury, December 23, 1915 | | $621.31 |
| By amount received for dues, 1916 | | 457.00 |
| By amount received from interest on deposits | | 5.86 |
| To stenographic report 1915 meeting | $58.00 | |
| Buttons 1915 meeting | 14.66 | |
| Stamps and stamped envelopes | 29.42 | |
| Printing programs, blanks, etc | 78.25 | |
| Telegraph and express | 2.73 | |
| Miscellaneous supplies | 8.13 | |
| Pacific Slope Branch expenses | 15.23 | |
| Official seal | 12.00 | |
| Clerical work, Secretary's office | 38.00 | |
| One-half salary of Secretary | 50.00 | |
| | $306.42 | |
| Balance, December 20, 1916 | 777.75 | |
| | $1,084.17 | $1,084.17 |

Balance deposited as follows:

| | |
|---|---|
| Melrose Savings Bank | $151.32 |
| Malden National Bank | 626.43 |

JOURNAL STATEMENT

| | | |
|---|---|---|
| Balance in Treasury, December 23, 1915 | | $755.02 |
| By amount received for subscriptions, advertising, etc., 1916 | | 2,281.07 |
| To stamps and stamped envelopes | $24.74 | |
| Printing | 1,784.58 | |
| Halftones, etc | 273.94 | |
| Miscellaneous supplies | 20.86 | |
| Refunds on subscriptions | 2.60 | |
| Returned checks | 7.50 | |
| Clerical work, Editor's office | 70.00 | |
| Clerical work, Secretary's office | 55.00 | |
| Salary, Editor | 100.00 | |
| One-half salary of Secretary | 50.00 | |
| | $2,389.22 | |
| Balance, December 21, 1916 | 646.87 | |
| | $3,036.09 | $3,036.09 |

Deposited in Malden National Bank $646.87

Respectfully submitted,

A. F. BURGESS, *Secretary.*

On motion the report was accepted, and the financial part referred to the auditing committee.

VICE-PRESIDENT GEORGE A. DEAN: We will now hear the report of the executive committee.

## REPORT OF THE EXECUTIVE COMMITTEE

The Executive Committee has pleasure in announcing that the question of a seal has been settled in accordance with the wishes of the Association and the instructions received at the last meeting. The committee was empowered to select either a plain seal or one bearing a profile of Harris and to have the seal prepared for official use. Under the direction of the President a design was made which included a profile of Harris, and the seal which has now been cut and completed is submitted for inspection. It is hoped that the result will meet with the approval of the members of the Association.

The President and Trustees of the Rutgers College of New Brunswick, N. J., invited the Association to send a delegate to the celebration of the 150th anniversary of the founding of the college which was held at New Brunswick, N. J., on October 13 to 15. Accordingly the President appointed Mr. P. J. Parrott of Geneva, N. Y., to represent the Association on this occasion. Mr. Parrott attended the celebration and has submitted an interesting account of the Proceedings; his report is included in the records of the Association.

C. Gordon Hewitt,
E. D. Ball,
W. J. Schoene,
T. J. Headlee,
A. F. Burgess,
*Executive Committee.*

By vote of the Association the report was adopted.

Vice-President George A. Dean: The report of the Employment Bureau is now in order.

## ANNUAL REPORT OF ENTOMOLOGISTS' EMPLOYMENT BUREAU

December 26, 1916.

The Entomologists' Employment Bureau, organized five years ago, seeks to interest and help in the most impartial and impersonal manner possible, both employers and employees in the field of entomology. Its policy, under the present administration, has been, therefore, simply to bring together candidates seeking positions in various phases of entomological work and those employers who are responsible for the recommendations or appointments to such positions. When information concerning a possible position comes to the attention of the Bureau, it has been the practice to furnish to the employer a list of several names of such men as appear from their enrollment blanks to be best fitted for the position in question and possibly available for the appointment. An abstract of the principal points given on the enrollment blank with the names of parties to whom the candidate refers for additional information is furnished the employer for each name. (Copies of the forms used may be obtained on application.) It is expected that the employer should then select and communicate with such candidates as he desires to investigate further. Notice is also sent to each candidate whose name has been thus used, giving him notice of the reference so that he can, if he so desires, get into direct communication with the employer and learn full details regarding the position, and present complete and up-to-date information regarding his own qualifications for appointment.

During the calendar year 1916, twenty-two new names have been enrolled in the Bureau. Two men have received the total of 10 references offered by the Bureau for the enrollment fee of $2, and one of these has re-enrolled. The total number on the roll at present is 63.

Information has come to the Bureau regarding twenty-one openings, and among these, nine men suggested by the Bureau have been definitely placed, with eight more from which we have not yet heard because of recent notifications. One hundred sixty-one (161) names have been suggested to these possible employers for their further consideration and selection of such candidates as seem to be best fitted for the particular work desired. Nearly five hundred (500) letters have been sent out during the year.

During the five years that the Bureau has existed, it appears that a total of ninety-five (95) men have enrolled and at least twenty-five appointments have resulted through the services of the Bureau. This number is doubtless considerably less than the actual number of appointments, since it frequently happens that no direct information regarding the appointment is given to the Bureau.

An effort has been made this year to secure a general expression of opinion from employers and employees as to the value of the Bureau services to them, and also to bring out frankly whatever criticism might be made regarding the work of the Bureau and as a guide in future policy. Thirty-four (34) men have responded with their opinions regarding the Bureau. Of the employers, nine have found the Bureau of service to them; seven have had no occasion to use the Bureau; one expressed the opinion that there is "no field for the Bureau," although he had had no occasion to try it; no employer has expressed condemnation of either the policy or services offered by the Bureau.

Among the candidates for appointments, fourteen (14) have expressed appreciation of the helpful services rendered them, in some cases even where a change of position has not occurred. Three have expressed the feeling that the information furnished them by the Bureau has been too meager to be satisfactory. (It should be noted here that the information upon which the Bureau works is always meager, and this is one reason why it has been expected that employer and employee should correspond directly for complete information. A revised form of notification cards would make this point entirely clear.) Three (3) men seem to feel that it is a fault in the Bureau because information regarding various positions has come to them through other sources, at the same time some of the same men admit that they have not informed the Bureau regarding such openings, even where they have not considered them seriously themselves. We would suggest in this connection that the Bureau may be of much greater service if it can receive hearty coöperation from all members of the Association of Economic Entomologists.

Financial statement of the Bureau is presented herewith:

| | *Dr.* | |
|---|---|---|
| Cash on hand January 1, 1916 | $48.70 | |
| To 22 enrollment fees at $2 | 44.00 | |
| Total receipts | | $92.70 |
| | *Cr.* | |
| April 11, 1916, to multigraphing letters (voucher 1) | $1.00 | |
| April 30, 1916, stenographic work (voucher 2) | 10.00 | |
| September 30, 1916, to stenographic work (voucher 7) | 5.00 | |
| November 24, 1916, to multigraphing letter (voucher 3) | 1.25 | |
| December 26, 1916, to stenographic work (voucher 4) | 7.50 | |
| December 26, 1916, to 500 envelopes (voucher 5) | 2.40 | |
| December 26, 1916, to stamps (voucher 6) | 10.00 | |
| Total | | 37.15 |
| Balance cash on hand, Bank of Auburn, Ala., December 26, 1916 | | $55.55 |

W. E. HINDS, *In Charge.*

NEW YORK, N. Y., December 28, 1916.

We have examined this statement and have found it to be correct.

W. E. BRITTON,
R. A. COOLEY,
*Auditors.*

By vote of the Association the report was adopted and the financial report referred to the auditing committee.

VICE-PRESIDENT GEORGE A. DEAN: We will now hear the report of the committee on nomenclature, Mr. Herbert Osborn.

The committee on nomenclature had no formal report to offer at this meeting.

VICE-PRESIDENT GEORGE A. DEAN: Next in order is the report of the committee on entomological investigations.

MR. W. E. HINDS: Last year no report of the committee on entomological investigations was published. Owing to a misunderstanding I did not know that it was necessary for me to prepare the report this year, hence the inquiries in regard to obtaining the information was sent out rather late in the season. As a result, replies have been received from only a part of the members to whom letters were written. As soon as full replies are received the matter can be turned over to the JOURNAL for printing, if it is the wish of the Association that it be handled in this way.

MR. E. P. FELT: I do not wish to be considered as in any way criticising the committee, but I would like to raise the question at this time as to the actual value which the members receive from the publication of this report, and whether it is the intention to publish the projects of the United States Bureau of Entomology. In the past, they have been issued as a government publication, and it would not seem desirable to duplicate them in the JOURNAL.

MR. W. E. HINDS: I would be very glad to have an expression of opinion from the members as to the value of the reports of the committee on entomological investigations. Under the present arrangement, these must be rather lengthy if they are to be at all complete. It is not the intention, however, to publish the projects of the Bureau of Entomology.

MR. W. C. O'KANE: A few years ago there was some discussion as to the advisability of publishing this report once in two or three years instead of annually. I believe myself that it should be published once in a while. If some of the remarks under the projects were cut out, I think it would make the report somewhat shorter and perhaps just as valuable.

MR. T. J. HEADLEE: It seems to me these reports are valuable, but

they should be available before the meeting in order that a member may have an opportunity to consult with other members working on the same lines, at the time of the annual meeting. If mimeograph copies of the report were available at the meeting, I think it would be very helpful as it would give an opportunity for the members to talk over these matters.

A general discussion followed as to the best form for presenting the report, and, on motion, the matter was referred back to the committee with a request that the suggestions be considered and recommendations reported at the last session of the meeting.

VICE-PRESIDENT GEORGE A. DEAN: We will now have the report of the committee on index of economic entomology.

## REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

Through the coöperation of Dr. L. O. Howard, chief of the U. S. Bureau of Entomology, and the devoted labor of Dr. Nathan Banks, the completed manuscript of the Index of American Economic Entomology is in the hands of the chairman of the committee. We regret to state that it has not been possible to secure the publication of this extremely valuable compilation by the U. S. Bureau of Entomology, though a very special effort was made on behalf of the project.

Previous action authorized the committee and the Secretary of the Association, who is also a member of the committee, to proceed with the publication of this work in the event of its being impossible to find any other satisfactory publishing agency. The latter has proved to be the case. The freedom of the committee was limited, however, by the adoption of a motion at the Atlanta meeting providing for the fixing of the maximum price of copies by the Association. The manuscript has been held since last September and the committee has limited itself to obtaining figures and considering details.

The printer's charges for an edition of 1,000 cloth bound copies in 8-point type would approximate very closely to $1,300 and in addition there would be some expense for author's corrections, the proofreading of the 350 pages in the editor's office, postage, etc. These latter are relatively small items. We prefer not to count on selling more than 200 copies at the outset though the probabilities are good that a much larger number can be sold within a five-year period.

The committee recommends that the editorial board of the JOURNAL OF ECONOMIC ENTOMOLOGY be authorized to proceed with the publication of the index and further, that the price of the index be fixed by the Editorial Board.

Furthermore, we recommend that the committee on the index be continued and specially charged with providing for the indexing of subsequent literature with a view to its publication later.

Respectfully submitted,

E. P. FELT,
W. C. O'KANE,
W. E. BRITTON,
A. F. BURGESS,
W. E. HINDS,
*Committee.*

MR. E. P. FELT: I would call attention to the fact that two different propositions are embodied in this report. The first—to give the editorial board of the JOURNAL authority to publish the index and to fix the price; second—to continue the commmittee in order to have indexing of current publications kept up to date, so that another index can be published as soon as it is deemed advisable. The committee believes that it will be possible to arrange with Dr. Howard, chief of the Bureau of Entomology, to have this indexing done in the Bureau, but it seems desirable that the committee be continued to make the necessary arrangements.

While it is not desired to make money on this index, it is very necessary that the returns from the sale of the publication be sufficient so as not to involve the Association too deeply from a financial standpoint. A plan has been suggested to offer the volume to members for a limited period at an advance price of $4 per copy, about one month being given the members to take advantage of this opportunity, after which time the price will be increased. If we sell 250 copies, we will be able to handle the publication without embarrassing the treasury.

MR. G. W. HERRICK: From the figures submitted in the report, I presume an edition of 1,000 copies would require an outlay of about $1,500. If all were sold, $4,000 would be realized. I am wondering what would be done with the surplus funds. Of course it is improbable that we could sell 1,000 copies immediately. If the price could be made lower, I think more copies would be sold at once.

MR. E. P. FELT: I would like to set the price lower but do not feel that we ought to run the risk of involving the Association. We have figured conservatively on being able to sell 200 copies. Personally I am inclined to think we could sell as many at $4 as at $3.50. We cannot figure that every member will buy a copy, and there will probably be a large reserve stock left over from which the Association will not realize anything for a number of years.

A MEMBER: Would it not be a good idea for the committee to canvass the Association, addressing all the members as to whether they would subscribe at different prices and in this way get an idea as to the price that should be fixed.

SECRETARY A. F. BURGESS: In handling this matter, I think the clerical work should be cut down to a minimum. We believe that this publication can be ready for distribution early in March. If a man is notified that he can receive a copy at a reduced rate before a given date, he can place his order enclosing payment, and the whole matter is settled in a single transaction. I think this would work out very satisfactorily and will reduce the clerical labor to a minimum.

By vote of the Association the report of the committee was accepted and recommendations adopted.

VICE-PRESIDENT GEORGE A. DEAN: Inasmuch as Dr. Hewitt will probably be here tomorrow, the chair will appoint only one committee, that on auditing. As there is considerable work for this committee to do, it seems desirable that the appointment be made at once. I will therefore designate Mr. W. E. Britton and Mr. R. A. Cooley to take charge of the auditing.

Is there anything that should come up under the head of miscellaneous business?

SECRETARY A. F. BURGESS: At the last annual meeting a committee was appointed to consider the matter of arranging the time of meeting, and the program. Unfortunately this committee was not able to present a report at the last session. It was the sense of the meeting, however, that the Secretary arrange the program for this meeting after consultation with the secretary of the Entomological Society of America. Probably there is no one present who has looked over this program that does not realize that it is exceedingly crowded. This has been necessary in order to get all the papers included. If it is the wish of the Association to jam forty papers into two sessions, the Secretary can do it, but if we want more time, we must make arrangements to have it. I would like to see the matter considered by a committee at this meeting, so that the wishes of the Association may be complied with.

MR. T. J. HEADLEE: Some of us are very anxious to be able to attend the sessions of this Association and those of the Entomological Society of America, and we hoped that there would be no conflicts. There have been, however, at this meeting, and I do not think it possible to escape them. If there are any, it is a question of the survival of the fittest. The point made by the Secretary that he can jam forty papers into two sessions is an indication that the number of papers is so large that the time we would naturally use for coöperation with other Associations is taken up. I am in sympathy with the idea of making an effort to arrange the programs in harmony, and I think a committee should be appointed to take the matter up and report at a later session.

SECRETARY A. F. BURGESS: The program was arranged this year so that there would be no conflict in time between the meeting of the Entomological Society of America and this Association and its sections.

MR. W. A. RILEY: As long as this matter is bound to come up year after year, some settlement should be made, and I think a committee should consider the matter.

MR. W. E. BRITTON: I believe a committee should be appointed, and that the secretaries of the various sections should be members of the committee.

SECRETARY A. F. BURGESS: I would rather not be a member of the

committee, but think that the matter should be considered by a committee made up of members of the Association, so that a better arrangement can be made in the future.

MR. E. P. FELT: I do not believe we ought to excuse our Secretary from being a member of the committee inasmuch as he is familiar with the details in making up a program.

MR. J. G. SANDERS: I am a member of the Entomological Society of America and have a feeling that one of the difficulties experienced with their sessions is that they place no limit on the length of the papers. I have listened to papers which occupied 35 to 45 minutes and could not help feeling that the information could have been greatly condensed and much time saved. I believe the matter should be considered at this meeting.

It was voted that a committee of three be appointed to consider the matter and report at the last session.

SECRETARY A. F. BURGESS: I have a letter from Dr. Howard, secretary of the American Association for the Advancement of Science, stating that all members of our Association who are not members of that association can join before January 1, 1917, without payment of the entrance fee of $5.

MR. J. J. DAVIS: Professor T. D. A. Cockerell brought up a matter at the meeting of the Entomological Society of America yesterday in regard to present conditions at the National Museum, and a committee was appointed to consider the matter of extending the entomological work in the National Museum. I believe all of our members are interested and I would therefore move that a committee of five be appointed to coöperate with the committee of the Entomological Society of America. It was voted that this committee be appointed.

VICE-PRESIDENT GEORGE A. DEAN: Is there any further business?

MR. R. A. COOLEY: I would like to bring up a matter in connection with the relation of our sections to the Association, as I think there is some difference of opinion among our members concerning it. The question of arranging sections on different activities should also be considered, and I believe a committee should be appointed to consider the matter.

It was voted that a committee of three be appointed to report at the final session.

VICE-PRESIDENT GEORGE A. DEAN: I will now call for the report of Mr. P. J. Parrott, who was our special representative at the 150th anniversary of Rutgers College.

## REPORT OF DELEGATE TO THE ANNIVERSARY OF THE FOUNDING OF RUTGERS COLLEGE

The one hundred fiftieth anniversary of the founding of Rutgers College was celebrated at New Brunswick, New Jersey, October 13–15, 1916, inclusive. The opening session of Friday morning consisted of commemoration exercises, the chief feature of which was a most interesting historical address by Dr. W. H. S. Demarest, President of Rutgers College. The afternoon was largely devoted to the anniversary pageant, which was given at the college farm in the open air with a charming, picturesque natural setting. In this exercise scenes of note in the history of the college and city and symbolical representations of the various branches of learning were presented by citizens, members of the faculty, graduate and undergraduate students. While there was no claim of absolute historical accuracy, either in action or costume, the performance showed great merit and made a strong appeal to æsthetic imagination and appreciation. As perhaps some of the members of our Association may recall, photographs of several of the scenes were subsequently reproduced in a number of the leading magazines and illustrated journals. The principal events on Saturday morning were the formal reception of the delegates, conferring of honorary degrees and presentation of addresses on behalf of colleges and learned societies. The remainder of the day was given over to attractions of special interest to the students and alumni. Sunday morning was noteworthy for the anniversary sermon and service, commemorating the connection between Rutgers College and the Reformed Church in America. In the afternoon the celebration was appropriately concluded with vespers, which was a service of praise and thanksgiving for the long and useful life of the college.

Other features of the celebration that might be briefly mentioned were the large number of delegates, representing about one hundred twenty-six universities and colleges, nine theological seminaries and twenty-eight or more learned and patriotic societies; the number of splendid addresses by men distinguished for their achievements in the academic world; the most hospitable entertainment, and various social activities, as receptions, luncheons and banquets, which were of increasing interest and pleasure with the development of comradeship among the delegates. Finally, as a fitting close, for an economic entomologist, to the many satisfying experiences of so short a period, a most enjoyable afternoon was spent in an automobile ride, through the courtesy of Doctor and Mrs. Headlee, to the salt marsh area of Newark where opportunities were afforded to see first hand some aspects of the mosquito problem and the progress of mosquito control in New Jersey.

Time does not permit a more extended account and references to other interesting aspects of the celebration are therefore omitted. Such, in brief, were the principal events of the auspicious anniversary of Rutgers College, an institution notable for a long period of honorable and effective service, high ideals of scholarship, and the many gifted and devoted sons she has nurtured, who occupy positions of trust and leadership throughout the land. That the achievements of a century and a half are but the harbingers of more magnificent accomplishments in the years that are to come is, I am sure, the wish of the American Association of Economic Entomologists, which society it was my privilege and honor to represent.

PERCIVAL J. PARROTT,
*Delegate.*

MR. T. J. HEADLEE: I trust the Association will allow me to express the appreciation of Rutgers College for the courtesy of sending a representative. The college appreciates it very sincerely, indeed.

VICE-PRESIDENT GEORGE A. DEAN: I will now appoint the following committees:

Committee to Consider Schedule of Meetings; W. C. O'Kane, A. F. Burgess and J. S. Houser.

Committee on Entomological Work at National Museum; J. J. Davis, E. P. Felt, R. L. Webster, Herbert Osborn and E. D. Ball.

Committee to Consider Relationship of Various Sections to the Association; R. A. Cooley, J. G. Sanders and E. F. Phillips.

On Friday morning, the following committees were appointed by President Hewitt:

Committee on Resolutions; George A. Dean, G. W. Herrick and F. L. Washburn.

Committee on Nominations; E. P. Felt, A. L. Quaintance and P. J. Parrott.

On Saturday morning in order to enable newly elected members of the Association to take advantage of the opportunity to become members of the American Association for the Advancement of Science at the reduced rate, the report of the committee on membership was presented.

## REPORT OF THE COMMITTEE ON MEMBERSHIP

The committee on membership respectfully submits the following report:

The committee recommends:

1. That the Secretary be instructed to notify members who are in arrears for dues that unless the same are paid promptly, their names will be dropped from the roll.

2. That the following named persons be elected to associate membership:

H. E. Backus, North East, Pa.
William J. Baerg, Ithaca, N. Y.
John Wendell Bailey, Agricultural College, Miss.
Arthur Challen Baker, Washington, D. C.
Parker T. Barnes, Harrisburg, Pa.
G. E. Bensel, Oxnard, Cal.
John W. Bradley, Melrose Highlands, Mass.
W. L. Chandler, Ithaca, N. Y.
Royal N. Chapman, St. Paul, Minn.
Leroy Childs, Hood River, Ore.
Frank R. Cole, Washington, D. C.
George A. Coleman, University of California.
Richard Thomas Cotton, Rio Piedras, P. R.
R. W. Doane, Stanford University, Cal.
Senekerin M. Dohanian, West Somerville, Mass.
Allen Bowie Duckett, Washington, D. C.
E. H. Dusham, State College, Pa.
Philip Garman, College Park, Md.
Louis G. Gentner, Madison, Wis.
Ernest Gram, Ithaca, N. Y.
Clyde Carney Hamilton, Ithaca, N. Y.
Dwight Isely, Washington, D. C.
Dettmar Wentworth Jones, Melrose, Mass.
Harry B. Kirk, Harrisburg, Pa.
J. L. E. Lauderdale, Baton Rouge, La.
A. L. Lovett, Corvallis, Ore.
Arthur C. Mason, Gainesville, Fla.
S. L. Mason, West Lafayette, Ind.
T. F. McGhee, Tallulah, La.
Charles W. Minott, Hudson, Mass.
B. W. Moreland, Tallulah, La.
Earl L. Morris, San José, Cal.
Harold Morrison, Washington, D. C.
George Franklin Moznette, Corvallis, Ore.

Carl F. W. Muesebeck, Melrose Highlands, Mass.
Harry L. Parker, Hagerstown, Md.
George W. Peake, St. Paul, Minn.
C. E. Pemberton, Honolulu, T. H.
Saul Phillips, Beverly, Mass.
Charles J. Pierson, College Park, Md.
Harold K. Plank, Washington, D. C.
Charles H. Popenoe, Washington, D. C.
Edwin Booth Powers, Urbana, Ill.
H. J. Reinhard, College Station, Texas.
Dean A. Ricker, Ames, Iowa.
John V. Schaffner, Jr., Dover, Mass.
Howard L. Seamans, Bozeman, Mont.
Albert F. Swain, San Diego, Cal.
William Burke Turner, Hagerstown, Md.
Ray T. Webber, Melrose Highlands, Mass.
William H. White, College Park, Md.
Percy Barnette Wiltberger, Orono, Maine.

3. That the following named persons be transferred from associate to active membership:

E. O. Essig, Berkeley, Cal.
B. B. Fulton, Geneva, N. Y.
J. W. McColloch, Manhattan, Kan.
J. H. Merrill, Manhattan, Kan.
F. B. Paddock, College Station, Tex.
J. R. Parker, Bozeman, Mont.
Morley Pettit, Guelph, Canada.
E. W. Scott, Vienna, Va.
H. S. Smith, Sacramento, Cal.
J. M. Swaine, Ottawa, Canada.
W. R. Walton, Washington, D. C.
V. L. Wildermuth, Tempe, Ariz.

4. That the resignation of Mr. G. H. Hollister be accepted.

5. That the membership committee for 1917 prepare a statement quoting that part of the constitution referring to membership, together with the records and the minutes of other action that the Association has taken from time to time, relating to qualifications for membership and, in addition, any further statement that may be necessary to interpret clearly the existing policy of the Association as to standards of membership, with the intent that this statement, after consideration by the Association, be printed on the back of the blank application for associate membership.

Respectfully submitted,

W. C. O'Kane,
J. G. Sanders,
J. J. Davis,
*Committee.*

President C. Gordon Hewitt: The report of the committee is open for discussion. In passing this report, you will, of course, adopt the recommendations made by the committee in regard to elections.

On motion the report was accepted and the recommendations adopted.

After the passing of this report, the question of membership was discussed, particularly the policy pursued by the membership committee in connection with promoting associate members to active membership. Mr. T. J. Headlee protested against the action of the committee in promoting too few associate members to active membership and offered a motion providing that a special committee be appointed by the chair to recommend for the consideration of the membership committee the men whom it believes ought to be included in the active list. The question was discussed by nearly all the active members present and by vote of the Association the motion was lost.

At the afternoon session, the following business was transacted.

PRESIDENT C. GORDON HEWITT: I will first call for the report of the auditing committee.

## REPORT OF THE AUDITING COMMITTEE

NEW YORK, N. Y., December 28, 1916.

We, the undersigned, have duly examined the accounts of W. E. Hinds, in charge of the Entomologists' Employment Bureau, and of A. F. Burgess, Secretary of this Association, and Business Manager of the JOURNAL OF ECONOMIC ENTOMOLOGY. All three accounts were found to be correct.

W. E. BRITTON,
R. A. COOLEY,
*Auditors.*

By vote of the Association the report was accepted.

PRESIDENT C. GORDON HEWITT: We will now hear the report of of the committee on resolutions.

## REPORT OF THE COMMITTEE ON RESOLUTIONS

Your committee submits the following.

1. The Association desires to express its sincere appreciation to the New York Entomological Society and to the Brooklyn Entomological Society for the enjoyable luncheon at the American Museum of Natural History and to the New York Zoölogical Society for the cordial reception at the Aquarium, and to Columbia University and the American Museum of Natural History for their generous hospitality and for the admirable facilities provided by them for the meetings of the Association.

2. The Association also takes this opportunity of expressing its appreciation of the great value of the recently completed Index of Economic Entomology and desires to extend to Dr. L. O. Howard its hearty thanks for affording the facilities of the United States Bureau of Entomology and its sincere gratitude to Mr. Nathan Banks for his untiring efforts in compiling this valuable work.

Respectfully submitted,

GEORGE A. DEAN,
GLEN W. HERRICK,
F. L. WASHBURN,
*Committee.*

On motion the report was adopted and the Secretary instructed to send a copy of the resolutions to the persons named in the report.

PRESIDENT C. GORDON HEWITT: We will now hear the report of the committee on entomological investigations.

## ENTOMOLOGICAL INVESTIGATIONS

In accordance with the instruction given me by the Association at the Thursday morning session, I would make the following recommendations regarding the report of the committee on entomological investigations.

1. That the report for 1916 be not published in the JOURNAL OF ECONOMIC ENTOMOLOGY as has been the custom heretofore.

2. That the material now in hand, together with such additional matter as may be reported to this committee, be compiled in as brief form as may seem serviceable

by arranging it in index form or otherwise as future committees may find possible and that a report be then prepared in mimeographed form and a copy be mailed to each active and associate member of the Association in America by December first of each succeeding year.

3. That the necessary expense in mimeographing and mailing this report shall be borne from the treasury of the Association of Economic Entomologists.

Respectfully submitted,

W. E. HINDS,
*Chairman for 1916.*

By vote of the Association the report was accepted and recommendations adopted.

PRESIDENT C. GORDON HEWITT: We will next have the report of the committee on programs.

MR. W. C. O'KANE: In the week of next year that corresponds to this week, Christmas will come on Tuesday. When the American Association for the Advancement of Science will schedule its meetings, we do not know. The committee is therefore unable to suggest a program for next year that will specify days of the week. Instead it is submitting for your consideration a plan covering any succeeding year, as follows:

## REPORT OF THE COMMITTEE ON FUTURE PROGRAM

The committee appointed to consider the matter of program for future meetings beg leave to submit the following report:

Owing to the continued growth of this Association and its sections, and the increasing difficulty in adequately presenting the program, it is recommended that three consecutive days be devoted to the sessions of the American Association of Economic Entomologists, and that no session be scheduled for Saturday afternoon.

Respectfully submitted,

W. C. O'KANE,
A. F. BURGESS,
J. S. HOUSER,
*Committee.*

MR. W. C. O'KANE: By three consecutive days is meant three consecutive periods of twenty-four hours, which might begin at noon on one day and end at noon of the second day following; or might begin in the morning and end in the evening of the second day following. This is intended to include the meetings of the sections.

MR. T. J. HEADLEE: I take it that the report means that we are to disregard the meetings of the Entomological Society of America.

MR. W. C. O'KANE: Perhaps I ought not to say more than is in the committee's report, but we have looked at the matter in this way. A week has six working days. We can begin our sessions on Thursday morning and end them before Saturday afternoon. There are present in this hall twelve or thirteen members of this Association to transact

the business. The committee believes that we should not attempt to hold a session on Saturday afternoon. Experience here and at previous meetings indicates that we need three days, or half of the total week for the meetings of our Association. The remainder of the week can be taken up by any other society, including the Entomological Society of America, if it desires.

PRESIDENT C. GORDON HEWITT: I think it is generally understood that it is the wish of the members that in arranging dates, the Secretary of our Association should notify the Secretary of the Entomological Society of America what dates we are selecting because it would be extremely unfortunate if we knowingly or without taking any trouble in the matter clashed with the times of their meetings when it could be possibly avoided, as there are many members of our Association who are almost equally interested in both meetings.

SECRETARY A. F. BURGESS: I would like to say that the committee endeavored to confer with the Secretary of the Entomological Society of America before preparing this report, but found that he had left the city earlier in the day. We talked the matter over with one of the executive board of that society and it did not seem possible to arrange to accommodate every one. The Entomological Society of America has always been advised in advance in regard to the time for holding our meetings, and this course will be followed in future.

By vote of the Association the report was accepted and the recommendations adopted.

PRESIDENT C. GORDON HEWITT: I will now call for the report of the committee to consider the relation between this Association and its sections.

## REPORT OF COMMITTEE ON RELATIONSHIP OF SECTIONS AND BRANCHES TO THE CENTAL ASSOCIATION

Your committee appointed to consider the relationship of sections and branches to the central organization respectfully submits the following:

We recommend that the official name of the Horticultural Inspectors be changed from American Association of Official Horticultural Inspectors to Section on Horticultural Inspection.

We recommend that the official name of the apiary inspectors be changed from Section on Apiary Inspection to Section on Apiculture, and that their activities be extended to include research in apiculture and education in apiculture.

As a guide in establishing any future sections and to record a definition of the activities of existing sections, we recommend that the purposes of sections be understood to be to discuss topics which are of such special nature as to be of only general interest to the majority of the members and of special interest to a limited number.

Respectfully submitted,

R. A. COOLEY,
J. G. SANDERS,
E. F. PHILLIPS,
*Committee.*

MR. R. A. COOLEY: In connection with this report, I would like to say in regard to the change in the name of the Section of Apiary Inspection that this is desired by that section so as to enable it to consider research and educational matters in connection with apiculture as well as inspection work. There is, of course, no membership in the sections other than membership in the central Association and any members of the Association are permitted to attend meetings of the sections and take part in their deliberations.

I am quite certain that this statement will clear up some uncertainty among our membership. Papers presented at the sections are printed in the JOURNAL, and it is of course understood that no action on policy can be taken by a section that would commit the Association without referring the matter to it for approval.

PRESIDENT C. GORDON HEWITT: The next business is the nomination of JOURNAL officers by the advisory committee.

The advisory committee of the JOURNAL OF ECONOMIC ENTOMOLOGY makes the following nominations:

Editor, E. P. Felt.
Associate Editor, W. E. Britton.
Business Manager, A. F. Burgess.

(Signed) ADVISORY COMMITTEE.

By vote of the Association the recommendations were adopted.

PRESIDENT C. GORDON HEWITT: We will now listen to the report of the committee on nominations:

## REPORT OF THE COMMITTEE ON NOMINATIONS

The committee on nominations begs leave to submit the following report:
For President, R. A. Cooley.
For First Vice-President, W. E. Hinds.
For Second Vice-President, A. W. Morrill.
For Third Vice-President, G. M. Bentley.
For Fourth Vice-President, B. N. Gates.
Committee on Nomenclature, G. W. Herrick.
Committee on Entomological Investigations, W. J. Schoene.
Committee on Membership, W. E. Britton.
Councillors to the American Association for the Advancement of Science, C. P. Gillette, H. A. Gossard.
Members of Advisory Committee, L. O. Howard, E. L. Worsham.

Respectfully submitted,

E. P. FELT,
A. L. QUAINTANCE,
P. J. PARROTT,
*Committee.*

By vote of the Association the secretary was instructed to cast one ballot for the election of the members named in the report. The ballot was cast and they were declared elected.

It was voted that the next annual meeting be held at the same time and place with that of the American Association for the Advancement of Science.

PRESIDENT C. GORDON HEWITT: We have now come to a final adjournment, but before adjourning, I would like to say what a pleasure it has been to me to preside over the greater part of the sessions. I only regret that I was prevented by illness from attending the first sessions. I should like to express my gratitude to Vice-President Dean for his kindness in taking my place at that time. I should also like to thank all the members of the various committees for the careful way in which they have carried out their duties, which are not always pleasant to perform, but I think every one will agree that these committees have done their work well.

There being no further business, the meeting adjourned at 3.55 p. m.

Respectfully submitted,

A. F. BURGESS,
*Secretary.*

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## PART II. PAPERS AND DISCUSSIONS

VICE-PRESIDENT G. A. DEAN: We will now take up the reading of papers. A letter has been received from Mr. Fiske stating that he would be unable to be present. I will therefore call for a paper by Prof. C. R. Crosby and Mortimer D. Leonard.

### THE FARM BUREAU AS AN AGENCY FOR DEMONSTRATING THE CONTROL OF INJURIOUS INSECTS

By C. R. CROSBY and M. D. LEONARD, *Ithaca, N. Y.*

With the establishment of farm bureaus and with their subsequent growth, not only in numbers but also in efficiency and popularity, a new agency has been created for the dissemination of knowledge relating to the control of insect pests. This development is one that should be welcomed by those entomologists interested in making this knowledge available to the greatest possible number of persons engaged in agricultural pursuits.

The task confronting extension workers in entomology is not to "popularize" their subject, in the ordinary sense of the term, but to teach the farmers those entomological facts that have a direct bearing on their problems, and thereby induce them to incorporate such prac-

tices into their business as will prevent the greatest amount of loss from insect attacks.

Experience has shown that this result cannot be satisfactorily attained through the distribution of bulletins, circulars and leaflets, or by means of the popular lecture at farmers' meetings. The bulletin is laid aside and the lecture is soon forgotten. In order to induce farmers to modify their practices, it is necessary to convince them of the practicability and profitableness of such action. In most cases this cannot be done except through local demonstrations. With the small staff available for such work, even in the larger agricultural colleges, such demonstrations must be limited to relatively very few communities in the state. However, by coöperating with the farm bureau manager in each county, the extension worker from the college will be able to have demonstrations conducted in any community where conditions are such as to make them desirable. Not only does such an arrangement greatly increase the number of persons reached, but the college representative can learn much of local conditions and needs through the farm bureau association and its local committees.

In New York state, the Farm Bureau first of all consists of an organization of farmers joined together so as to act as partners with the College of Agriculture and the United States Department of Agriculture for the development of agriculture in their country. This association elects an executive committee which, jointly with the College of Agriculture, hires the farm bureau manager and decides along what lines work should be undertaken. In addition to this executive committee, each county has an advisory council composed of one to three association members from each community. It is through the members of this advisory council that the needs of each locality are brought to the attention of the executive committee. Under this method of organization the college extension worker can count on the coöperation not only of the farm bureau manager but also on that of the members of the association and its committees.

The farm bureau manager is usually a graduate of some agricultural college who, since his graduation, has had several years successful experience in conducting a farm business. He has had thorough training in the fundamental sciences of agriculture and his years of practical experience have tempered his enthusiasm and seasoned his judgment. He has a greater appreciation of the value of scientific work than the farmer, and he usually has a better knowledge than is possessed by the college extension worker of the difficulties and limitations experienced in attempting to incorporate the results of scientific investigation into a system of farm practice. He functions as a differential between the scientific wheel that tends to run too fast and the practical wheel that is inclined to go too slowly.

The farm bureau manager is in close touch with the needs of each community in his county and can give the college worker much valuable advice as to the subjects in which demonstrations are needed and as to the points requiring special emphasis. Through the local committees of his association, he is able to have the demonstrations located on the most suitable farms in each community and thus insure the work being conducted in a business-like manner. Where demonstrations are conducted as the result of a local demand and where the local organization has a voice in deciding on their location, greater interest is developed than where the whole program is conducted by outside agencies. Furthermore, under such circumstances, the demonstrations will be more likely to have a direct bearing on the needs of the community. There is also less danger of getting a poor coöperator; the local committee feels a considerable responsibility for the success of the demonstration and a larger number of farmers become familiar with all the details of the work.

In coöperative work of this kind, it is important that the demonstrations should be adapted to the conditions under which the crop is grown. For instance, while apples are grown more or less in every county of New York state, there are certain counties in which apple growing has become a specialized industry. To do effective demonstration work in the control of apple insects, this difference must be kept in mind. In those counties where most of the apples are grown in the small home orchard, the best results will probably be obtained by showing the advantages of following a rather simple spraying schedule. In some localities it might even be advisable to hold spraying demonstrations, but only where the growers are entirely unfamiliar with spraying machinery, spraying materials and methods of application. Such demonstrations would be entirely out of place in the localities where the growing of apples is a specialized industry. Here, demonstrations showing the relative value of different methods of application, different insecticides or different combinations of insecticides with fungicides would arouse greater interest and be of more permanent value to the community. The same condition holds in the case of potatoes. Where potatoes are not an important crop demonstrations of the benefits derived from spraying for the control of blight, the Colorado potato beetle and flea-beetle are all that is needed. In those localities, however, where potato raising is the main industry, demonstrations showing the comparative value of different forms of arsenical poisons (arsenate of lead, paste or powdered; Paris Green; or arsenite of soda) would be of greater benefit to the growers. In other words, the subjects for demonstration should be so chosen and so conducted that they actually help the grower to fight the insect enemies

of his crop in a practical way, that is, under the conditions actually existing on his farm.

It should also be remembered that, while it is important to so arrange demonstrations that they shall be of practical value and on a commercial scale, the main emphasis should be on the reasons for the success or failure of the work. By maintaining this attitude, successful demonstrations become of greater educational value and even failures may be made to teach important lessons. This is especially true of demonstrations of insect control where there are so many factors to be considered not under the control of the grower—such as weather, early or late seasons, severe or mild winters and the relative degree of development of plant and insect at critical times in the season.

In this connection, it might be well to point out that as far as insect work is concerned the farm bureau manager's activities fall under two heads—first, conducting formal demonstrations; and second, giving expert advice to those farmers engaged in growing special crops such as fruit or vegetables. In most cases the two methods can be combined to advantage. While many questions of insect control may properly serve as subjects for formal demonstrations, the local adviser in fruit growing regions will find that his services will be of much greater value to growers if he constantly keeps in very close touch with the insect situation and is able to give the growers expert advice as to the proper sprays and the proper time for applying them. Isolated formal demonstrations of methods of insect control cannot be of as great money value to the growers of a community as would results from continued and timely attention to their spraying problems throughout the season. The latter method has been tried out with highly satisfactory results in at least one county in New York where an assistant to the farm bureau manager was available to give his entire time and attention to this work throughout the season.

It is important to determine as definitely as possible what are the more serious insect problems in each locality. In this way it would be possible to concentrate attention on demonstrating the control of those insects which are most destructive and so prevent wasting energy on work against insects which are less injurious but which, on account of their novelty or conspicuousness, more often attract the attention of the grower. It is therefore desirable to determine as definitely as possible for each locality what are the most important insect problems before deciding upon a subject for demonstration. While this may be already known in a general way, there are many cases in which such information is lacking. In some instances it might be desirable to conduct surveys of insect problems in the growing of certain crops. For instance, an arrangement could be made with the farm bureau

manager for a survey of the insect problems in the greenhouses of his county, or a similar survey might be conducted among the vegetable growers.

In coöperating with the farm bureaus, it is important that there should be a definite understanding as to the nature and extent of the work. It is realized, however, that it is not always easy to plan demonstration work in insect control in advance of the season. The relative importance of even our most common pests varies greatly from year to year and it often happens that the greatest injury is done by an entirely unexpected insect. In spite of this fact, demonstration work should be planned as definitely as possible and adapted to the conditions under which the crop is grown. In conducting demonstrations, the aim should be to obtain as definite results as conditions will permit. In field tests of the methods of insect control, untreated plats should always be left for comparison. There are, however, some exceptions to this rule as, for instance, in the case of the pear psylla where it is necessary to treat the whole field to prevent reinfestation. Where the value of the crop is great, it is usually necessary to have the untreated area small in extent. This is especially true in orchards of large, old trees where few growers would care to lose the crop from more than two or three trees. In determining the results of field tests of methods of controlling insects, it is just as important to obtain definite data as in the case of fertilizer tests. General impressions are of little value. In some cases, as in the comparison of the effectiveness of different insecticides in controlling fruit insects, this entails a large amount of careful work—a tedious but necessary task, yet one well worth while. Results backed by definite figures have much more weight with those growers who are not able to see the tests personally than those presented as based on personal opinion or vague observation.

Since in many cases the control of insects must, in practice, be connected with the control of plant diseases, it is desirable that demonstrations be arranged whenever possible, in coöperation with the plant pathologist of the college.

In order to standardize spraying practice in a county, it is sometimes desirable to publish an extension bulletin on the control of insects for particular crops in that region. In such cases, the college representative would furnish the general discussion and illustrations, and the farm bureau manager would be able to contribute those finer points of control based on an intimate knowledge of local conditions that would make the publication of greater practical value in his county. Experience has shown that a bulletin prepared for a particular region or county is much more valuable to the growers than one written for the

whole state, because it is possible to make the directions more definite and to better adapt them to local conditions.

The farm bureau as organized in New York state has proved a most efficient agent for teaching methods of insect control in a practical way. Only a little over half of the agricultural counties of the state have farm bureaus, but when the whole state is organized it will be possible to reach any community quickly and effectively where there are insect problems needing a solution.

The farm bureaus offer facilities that greatly increase the efficiency of the extension work of the college. The responsibility of initiating and guiding this work along entomological lines rests upon the extension entomologists of the colleges. The problems to be solved are problems of applied entomology. They must be worked out by persons whose training and main interest are in entomology. They cannot be solved by the professional extension worker whose interest in entomology is secondary and whose knowledge of the subject is superficial.

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VICE-PRESIDENT G. A. DEAN: The next paper on the program will be read by Mr. B. H. Walden.

## SIMPLE APPARATUS FOR INSECT PHOTOGRAPHY

By B. H. WALDEN, *Agric. Expt. Sta., New Haven, Conn.*

The subject of insect photography has been well covered by at least three papers read before this Association, containing much valuable information on the methods of technique which, to a certain extent, must be followed by all workers.

The present paper does not deal with this phase of the subject, but is rather a brief description of the simple photographic apparatus and methods for field and laboratory work used in the entomological department of the Connecticut Agricultural Experiment Station. Our laboratory photographs are made in one corner of the general workroom, where there is not room for a large and elaborate outfit, such as a camera and stand with an eight- or ten-foot bed. The work is done by the regular members of the department, often when the time could be used to advantage in the regular work. The apparatus then, should be as simple as possible, and easily and quickly adjusted. It usually follows that the larger or more elaborate the outfit, the more time it takes to manipulate it.

LABORATORY OUTFIT.—The stand of the laboratory camera is the regular Folmer and Schwing laboratory stand on which the camera

can be used horizontally or vertically (Pl. 1, fig. 1). The majority of our insect photographs are made with the camera in the vertical position. A 5 x 7 view camera and a home-made camera, which will be described later, are used on this stand. The lens used for the most of our photographs is an anastigmat of 4½-inch focus. The short focus lens has the following advantage over one of long focus for this work, (1) greater depth which increases as the focal length decreases and which, of course, is most marked in the micro-tessars; (2) the shorter bellows required and the shorter working distance in making photographs from natural size up to four or more diameters. The following figures illustrate this point. In photographing objects natural size with the 4½-inch lens, the distance from the focusing screen to the center of the lens is 8¾ inches. The working distance is also 8¾ inches, making a distance of 16½ inches from the ground glass to the object. Comparing an 11-inch focus lens, for example, the distance from the ground glass to the object is 44 inches. In photographing at two diameters, the total distance with the 4½-inch lens is 18 9-16 inches against 49½ inches with the 11-inch lens. In fact, the short focus lens is the key to the simple oufit which we use.

The specimens to be photographed are placed on a piece of fine ground glass with the ground surface up. The glass is supported on a frame which carries the background and can be raised or lowered. With the background at the proper distance below the ground glass, there is practically no trouble from shadows. The ground glass does not show reflections from the lens and metal parts of the camera, as is often the case with a plate glass support.

A 48 mm. micro-tessar lens is used for making enlarged photographs of small specimens, and with the 22-inch extension of the view camera, linear enlargements of ten times can be made.

The most of our exposures are made by daylight, white cardboard reflectors being used to illuminate the dark portions of the object. There is no doubt that the use of artificial light is advisable, especially when the natural light is poor, but it requires more or less skill in arranging the reflectors in order to obtain an even or pleasing illumination of the subject. The writer has used flash-light powder, without any special apparatus, in photographing insects when the natural light was not sufficient to make the exposure. About a teaspoonful of flash-light powder was placed on a sheet of tin slightly above and about two feet from the object. A large white cardboard reflector was arranged just back of the powder and similar reflectors were placed near the object, on the side opposite from the flash. The object was focused in the usual way and the lens stopped down to f. 16, a match on the end of a stick lighted, the cap removed from the lens, and the powder immediately touched off.

About 85 per cent of our laboratory photographs are either natural size or twice enlarged. A 5 x 7 box camera has been built to meet these requirements (Pl. 1, fig. 3). It consists of three sections built of one-half-inch wood and mounted on a baseboard which fastens to the sliding bed of the stand. The front section is firmly fastened to the baseboard and takes the regular lens board of the 5 x 7 view camera. The rear section slides up and down on the bed, and is fitted with a back from a regular camera. These two sections fasten together and with the 4½-inch lens form a fixed focus camera for photographing natural size. A third section 4½ inches long can be inserted between the other two sections, thus making the camera of the right length for photographing twice natural size (Pl. 1, fig. 4). The object can be centered by sliding the ground glass support back and forth in one direction and by moving the lens, which is mounted on a sliding lens board, in the other direction. This camera is absolutely rigid and is very simple and convenient to operate. The 48 mm. lens can be used to give the desired magnifications by means of extensions fitted in place of the regular lens board.

Field Outfits.—The department has three outfits for field work, a 5 x 7 camera with a triple entension, a 4 x 5 long bellows camera, and a 3¼ x 4¼ roll film camera. These cameras are all fitted with anastigmat lenses and good shutters. In addition to these, three members of the department have small high grade 2¼ x 3¼ cameras, which are very useful in field work. In fact, with the outfits mentioned above, their usefulness apparently increases as their size decreases. The small cameras are readily carried in the pocket, and are simple and inexpensive to operate. The high grade lenses, being of short focus, give sharp, clean negatives of good depth, which are capable of being enlarged to 8 x 10 or even to 11 x 14 inches. One of the most important features of these cameras is the fact that the negatives are just the right size for making lantern slides by contact.

In our 1915 report eight of the eleven illustrations showing field views were made from these 2¼ x 3¼ negatives.

Though the writer would not go so far as to recommend this size for all field work, he considers that the most useful size for a field outfit would be a compact plate camera, not larger than 3¼ x 4¼, with a long extension and fitted with a convertible anastigmat lens and a good shutter.

It is frequently necessary to make photographs in the field looking directly down on the ground. This can be accomplished by making a right-angled bracket of two pieces of board with a tripod socket in each; the horizontal part is fastened to the head of the tripod and should project far enough beyond the head to clear the tripod legs.

The camera is fastened to the vertical portion of the bracket and a tripod stay is advisable as the weight of the camera is at one side (Pl. 1, fig. 2). A view camera is much more convenient for this purpose than the average hand camera, as both the front and back can be racked up and down on the bed.

ENLARGING OUTFIT.—With the use of the small camera and the increasing demand for enlargements for exhibition purposes, an enlarging outfit is a necessary part of the entomologist's photographic equipment. Our enlarger consists of a box in which is mounted a "Parallex" reflector; the front of the box is fitted with ground glass and a negative carrier to which our regular 5 x 7 camera is attached (Pl. 1, fig. 5.). The enlarged image is projected upon an easel which slides back and forth on a board. The "parallex" is a concave reflector with a series of mirrors each of which gives an individual reflection of the incandescent bulb, for which a socket is provided at the center of the reflector. Our reflector covers a 5 x 7 plate, has 64 mirrors, and the maximum illumination is obtained with a 300-watt nitrogen-filled bulb. The cost is much less than that of a pair of good condensers covering the same sized plate, and in some respects is more satisfactory. With sufficient distance to move the easel, and a good negative, the size of the enlargement is limited only by the size of the developing trays. With a long bellows on the camera the apparatus is equally convenient for making lantern slides by reduction. This outfit is in the dark room where the space is limited and is mounted on a shelf that was formerly used for printing. The enlarging easel is removable and the board support slides under the shelf out of the way (Pl. 1, fig. 6). The camera and negative carrier can readily be removed and we have an excellent light for printing, so that the two feet of shelf space which the box occupies is not missed.

PLATE DEVELOPER AND PAPER.—Ortho- or isochromatic plates are used for practically all our work. Color screens are used when considered practicable. The plates are covered as much as possible during development, as there are no dark room lights which are absolutely safe with color value plates. Copies of charts or line drawings intended for lantern slides are usually photographed directly upon a lantern slide plate, developed in the lantern slide or contrast developer, and the slide printed by contact.

Pyro is one of the best developing agents for plates and is usually employed. Most workers have their favorite formula or developer so that it is not necessary to give one here. My experience is that many formulas call for too much sodium carbonate and too little water to give soft negatives of good gradation. The developer can often be modified to meet special requirements. The entomologist,

especially when engaged in medical entomology or similar lines, frequently wishes to photograph interiors where the light conditions are poor. The method used in making the illustration shown in figure 1 is useful when photographing directly against the light. The exposure given was sufficient to fully time the darkest portion of the object and was about ten times the normal exposure for the light conditions of the room. Development was started in a developer containing four or five drops of the carbonate solution instead of an ounce as ordinarily used. After the detail appeared a few drops of the carbonate solution were occasionally added, and the negative developed for about twenty minutes.

The prints intended for halftone illustrations are made on developing paper. In fact, at the present time practically all of the prints submitted to the local engraver for halftone work are on this class of paper. The loss of detail in our published illustrations has been due usually to unsuitable paper or to careless printing from the halftone plates rather than to poor halftones.

Lantern Slides.—In making lantern slides, a hydroquinone developer similar to the one recommended by the late Professor Slingerland has proven most useful. Also his potassium ferricyanide solution is excellent for local reduction. Weak or slightly underexposed slides can be considerably improved by redevelopment, the same as is used to produce sepia tones on bromide paper, providing, of course, the tone is suitable for the subject. It is often desirable to combine the views from two negatives on one slide. This can be done by alternately exposing each side of the plate, first covering one half of the plate with a card, making one exposure, and then covering the exposed side while the second exposure is being made. Care must be taken to have the exposures similar. An easier way to accomplish this is to make the first exposure on one plate and the second exposure on another plate, using the latter for the cover glass. If the reversed image of the second exposure is objectionable, the negative can be reversed in the camera before making the exposure.

A brief description of the method of indexing our negatives and prints

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Explanation of Plate 1

Fig. 1. Laboratory stand and view camera.

Fig. 2. Home-made bracket and tripod stay for photographing vertically.

Fig. 3. Home-made box camera for photographing natural size.

Fig. 4. The same with extension for photographing twice natural size.

Fig. 5. "Parallex" enlarger with side removed.

Fig. 6. Enlarger as used for printing.

may be of interest. The negatives when filed are numbered consecutively and catalogued in a book in the same sequence. After several negatives of a subject had been made, it was often necessary to examine a number of negatives to find the one desired. A card index is used to supplement the book catalogue. A print from each negative is mounted on a regular 5 x 8 index card. The subject and number of the negative is placed at the top and the cards are arranged alphabetically. The prints used are often some that are not suitable for halftones and are attached to the cards with binding strips or a non-curling gelatine mountant. Prints from two or more different negatives of the same subject are often mounted on the same card. This index has proven very convenient and saves much time in looking up negatives.

Thus with the simple apparatus and devices described, photographs up to ten diameters, prints, enlargements of any reasonable size and lantern slides can be quickly and conveniently made. This occupies less than seven square feet of space and could be duplicated for between $100 and $120.

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VICE-PRESIDENT G. A. DEAN: The paper is now open for discussion.

MR. G. W. HERRICK: I would like to ask if Mr. Walden has any trouble with shadows when he places his specimens on a horizontal shelf.

MR. B. H. WALDEN: The specimens are placed on a sheet of ground glass. Many workers use plate glass, but we prefer the ground glass and if the background is placed a proper distance below, we have very little trouble with shadows.

MR. W. C. O'KANE: Mr. Walden's statement with regard to a field camera with high grade lens is interesting. I should like to ask if he has had experience with supplemental lenses added to an ordinary lens thereby avoiding long focus bellows, because our experience with long focus has not been pleasant. I have not had any experience with supplementary lenses but should like to know about it.

MR. B. H. WALDEN: I have never used a supplementary lens for this work, but have seen one used in connection with other work and the results were not entirely satisfactory.

VICE-PRESIDENT G. A. DEAN: We will now listen to a paper by Dr. T. J. Headlee.

# SOME FACTS RELATIVE TO THE INFLUENCE OF ATMOSPHERIC HUMIDITY ON INSECT METABOLISM

By THOMAS J. HEADLEE, PH. D., *New Brunswick, N. J.*

The effect of atmospheric moisture (water vapor) upon the speed of insect metabolism is seemingly extremely variable. It has been shown that moist air retards in some cases the development of the eggs of *Dendrolimus pini*[1] while in other cases it seems to hasten it. Moist air hastens the development of the larvæ (change from larva to pupa) of *Mayetiola destructor*[2] and dry air greatly retards it. Dry air retards the development of the pupa of *Lygellus epilachnæ*[3] and hastens that of *Pieris brassicæ*[4]. Moist air is injurious to the adults of *Dorcadion sturmii*[5] but highly favorable to plant lice. Dry air, even when warm, causes lethargy in *Phytodecta viminalis*[6] and several other species.[7] Neither dry nor moist air materially affects the speed of metabolism in *Toxoptera graminum* when feeding on young and succulent wheat.[8]

The writer undertook the study of the response of the various stages of the bean weevil (*Bruchus obtectus* Say) for the purpose of finding out to what extent the variations of speed of metabolism in response to atmospheric humidity held true in a single species entirely dependent upon metabolic water and for the purpose of deriving data that might lead to the underlying cause of the response.

Realizing the extent to which factors such as temperature and light would interfere with the results and having an idea that the presence of carbon dioxide and oxygen might influence the results, an effort was made to eliminate them as variables. All insects were kept at a practically constant temperature of 80° F.; all were kept in complete darkness; all were subjected to a passing stream of air, the minimum

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[1] Serebrjanikaw, A. W., Nachr. des Forst. Instit. zu St. Petersburg, VII., p. 29–102, 1901.

[2] Headlee, Thos. J., and Parker, J. B., Bull. No. 188, Kans. St. Agr. Expt. Station, p. 107–109, 1913.

[3] Giard, A., La methode experimentale dans l'Entomologie, Bull. Soc. France No. 4, p. 57–63, 1896.

[4] Urech, Friedr., Chemisch-Analytische Untersuchungen an lebenden Raupen Puppen und Schmetterlingen und ihren secreten, Zoölog. Anz. 1890, No. 335, p. 254–262, No. 336, p. 272–280, No. 337, p. 309–314, No. 338, p. 335–345.

[5] Bachmetjew, P., Experimentelle Entomologische Studien, Band 11, p. 574, 1907.

[6] Kolbe, H. S., Einfürung in der Kenntnis der Insekten, 1889–1893.

[7] Bachmetjew, P., l. c., p. 688.

[8] Headlee, Thos. J., Jour. Ec. Ent., Vol. VII, No. 6, p. 416, 1914

rate of which was one liter in eight minutes or less. Barometric pressure was the only variable against which no fairly complete measures were taken. In so far as possible the influence of this variable was annulled by running the experiments simultaneously.

The first phase of the investigation was concerned with the effect of atmospheric humidity on late larval and the pupal stages and included the responses of both the bean weevil and the Angoumois grain moth (*Sitotroga cerealella* Oliv.).

TABLE SHOWING THE EFFECT OF ATMOSPHERIC MOISTURE ON RATE OF DEVELOPMENT OF THE LATE LARVAL AND PUPAL STAGES OF THE ANGOUMOIS GRAIN MOTH AND THE BEAN WEEVIL

| Chamber | Temp. | Atmospheric moisture | Date of beginning | Emergence | | No. of specimens |
|---|---|---|---|---|---|---|
| | | | | No. of days in period | No. of days to maximum | |
| **Angoumois grain moth** | | | | | | |
| Chamber No. 1 | 80° F. | 100 % | 1/17 | 17 | 9 | 26 |
| Chamber No. 2 | 80° F. | 72.6% | 1/17 | 17 | 7 | 8 |
| Chamber No. 3 | 80° F. | 44.7% | 1/16 | 16 | 11 | 8 |
| Chamber No. 4 | 80° F. | 21.8% | 1/15 | 12 | 6 | 16 |
| **Bean Weevil** | | | | | | |
| Chamber No. 1 | 80° F. | 100 % | 1/16 | 22 | 5 | 32 |
| Chamber No. 2 | 80° F. | 71.5% | 1/16 | 21 | 6 | 27 |
| Chamber No. 3 | 80° F. | 44.6% | 1/15 | 14 | 4 | 30 |
| Chamber No. 4 | 80° F. | 21.5% | 1/15 | 15 | 7 | 31 |

It is here unmistakably shown that the speed of metabolism in the pupa is increased, the period being shortened in case of the moth from 17 days in 100 per cent to 12 days in 21.8 per cent and in the case of the weevil from 22 days in 100 per cent to 14 days in 44.6 per cent.

The next phase considered was length of adult life which in all probability may be taken as a measure of the speed of adult metabolism.

In the moth the length of the period was shortened by a decrease in atmospheric humidity varying from 18 days at 100 per cent to 15 at 44.7 per cent and below. In the weevil, on the other hand, the period as a whole was apparently but little affected. When, however, period to maximum death is examined it becomes plain that the life of the adult weevil was prolonged by a decrease in humidity as shown by the increase of the period from 3 days in 100 per cent to 12 in 44.6 per cent and below.

TABLE SHOWING THE EFFECT OF ATMOSPHERIC MOISTURE UPON THE LENGTH OF ADULT LIFE FOR THE ANGOUMOIS GRAIN MOTH AND THE BEAN WEEVIL

| Date of beginning | No. of days in period | No. of days to maximum |
|---|---|---|
| **Angoumois grain moth** | | |
| 1/21 | 18 | 8 |
| 1/21 | 16 | 7 |
| 1/22 | 15 | 8 |
| 1/21 | 15 | 6 |
| **Bean Weevil** | | |
| 1/20 | 17 | 3 |
| 1/21 | 16 | 7 |
| 1/17 | 19 | 12 |
| 1/16 | 18 | 12 |

It seems that a decrease in atmospheric moisture increases the speed of metabolism in the moth and decreases it in the bean weevil.

The next phase investigated was the effect of humidity upon the length of the entire life cycle.

TABLE SHOWING THE INFLUENCE OF ATMOSPHERIC MOISTURE UPON THE LENGTH OF LIFE CYCLE IN THE BEAN WEEVIL

| | Chamber | Temp. | Moist. | Date when majority of 1st brood | Date when majority of 2nd brood have emerged | No. of days involved | No. of specimens | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | At beg. | At end |
| First Test | No. 1 | 80° F. | 100 % | is dead 2/5 | 2/25 | 20 | 25 | 150 |
| | No. 2 | 80° F. | 69.3% | 2/4 | 2/27 | 23 | 25 | 129 |
| | No. 3 | 80° F. | 44.1% | 2/2 | 2/29 | 27 | 25 | 11 |
| | No. 4 | 80° F. | 20.5% | 1/31 has emerged | Not at all | | 25 | 00 |
| Second Test | No. 1 | 80° F. | 100 % | 2/25 | 4/3 | 38 | 131 | 491 |
| | No. 2 | 80° F. | 59.4% | 2/27 | 4/6 | 39 | 129 | 27 |
| | No. 3 | 80° F. | 39.9% | 2/29 | 4/10 | 41 | 15 | 14 |
| | No. 4 | 80° F. | 23.6% | is dead | | | | |
| Third Test | No. 1 | 80° F. | 100 % | 9/3 | Fungi destroyed both beetles and beans | | 25 | 00 |
| | No. 2 | 80° F. | 62 % | 9/3 | 10/4 | 31 | 25 | 101 |
| | No. 3 | 80° F. | 26 % | 9/2 | Nothing emerged | | 25 | 00 |
| | No. 4 | 80° F. | 1 % | 9/1 | Nothing emerged | | 25 | 00 |

It is apparent from the records of the first and second brood that the rate of metabolism is decreased by a reduction in atmospheric

moisture, the period ranging from 20 days in 100 per cent to 27 in 44.1 per cent in the first brood and from 38 in 100 per cent to 41 in 39.9 per cent in the second brood. It seems clear that a reduction of moisture to 26 per cent or below absolutely prevents reproduction. It seems also that in 100 per cent fungi may develop to such an extent that both weevil and beans are destroyed.

The great reduction in progeny which accompanied the reduction in atmospheric moisture led to an investigation of the cause. Thinking that the reduction might be the result of reduced fecundity a study of that phase was undertaken.

TABLE SHOWING THE EFFECT OF DIFFERENT DEGREES OF ATMOSPHERIC MOISTURE ON THE NUMBER OF EGGS LAID

| Chamber | Temp. | Moist. | No. of days in period | No. of beetles | No. of females | No. of eggs per female |
|---|---|---|---|---|---|---|
| No. 1 | 80° F. | 100% | 14 | 25 | 16 | 43 |
| No. 2 | 80° F. | 62% | 13 | 24 | 9 | 27 |
| No. 3 | 80° F. | 26% | 8 | 25 | 9 | 30 |
| No. 4 | 80° F. | 1% | 8 | 25 | 12 | 29 |

While reduction in atmospheric moisture reduces the number of eggs produced by the average female, that reduction is certainly not sufficiently large to explain the observed reduction in progeny.

Accordingly attention was directed towards the egg stage. Eggs were subjected to two moistures 100 per cent and 23.6 per cent. They hatched in both but required an average of six days in the former and four in the latter. An examination seven days after the last egg hatched showed many of the beans in 100 per cent penetrated by the larvæ and a complete absence of penetrations among the beans under 23.6 per cent. This seems to show that the absolute prevention of progeny in 23.6 per cent is due to the destruction of the larvæ before they can penetrate the beans, and it seems not unlikely that the great reduction in progeny which accompanies reduced atmospheric humidity may be due to the same cause, although the effect upon the larvæ yet remains to be investigated.

It thus appears that the speed of metabolism in the pupæ of both the bean weevil and the Angoumois grain moth varies inversely with the atmospheric humidity; that in the adult of the former it varies with while in the adult of the latter it varies inversely as the humidity; that in the egg stage the speed of metabolism varies inversely with the humidity; that in the larvæ it varies with the humidity; that in the life cycle as a whole the speed varies with the humidity.

The bean weevil and the Angoumois grain moth offer many of the *variations* in response of speed of metabolism to atmospheric moisture

that were illustrated at the beginning of this paper and lend support to the theory which was partly set forth by Bachmetjew.[1] "Apparently there is a degree of atmospheric humidity, which being the most favorable to the maximum speed of insect metabolism should be designated as the optimum; that this optimum varies for each species, for each stage of each species, and for each stage of each individual."

When considering this question it must be remembered that we are dealing, in this instance, with species which are totally unable to imbibe and which must depend entirely upon metabolic water. According to Babcock[2] the sources of metabolic water are mainly three,—oxidations of food and tissues, breaking up molecular structure into new forms of a lower order, and changing the molecular structure of substances composing its nutrients and tissues without reducing their complexity. The first two produce $CO_2$ and all three produce metabolic water. It must also be remembered that when dealing with an insect or with insect stages which can imbibe the maintenance of the water optimum against the influence of evaporation is easy and that variations in atmospheric moisture may under such conditions prove ineffective as shown in the case of *Tozoptera graminum*.

Among insects or insect stages dependent upon metabolic water alone, this response to atmospheric moisture can best be accounted for on the supposition that for each stage of each insect there is a definite internal water optimum—an amount of body fluid which will permit necessary chemical and physical changes to take place with the greatest ease and speed. It would seem that atmospheric humidity can act upon the insect directly in two ways—by the removal of water, and by the prevention of the loss of body fluid.

Under the terms of this theory the direct effect of atmospheric moisture upon the specific stage of a specific insect depends upon the relation of the supply of body fluid to the optimum. If it be well above, dry air will remove the surplus and cause the metabolism to speed up as in the pupa or egg stage of the bean weevil, while moist air by preventing the rapid reduction of body fluid will prolong the stage. If the body fluid be just about the optimum, dry air will reduce it below that point and decrease the speed of metabolism while moist air will prevent the decrease of body fluid and shorten the time required to complete the stage of development as illustrated by the larvæ of the bean weevil.

Continued exposure to dry air will reduce the body fluid until the tissues become so poorly supplied that living processes can no longer

[1] Bachmetjew, P., l. c., p. 689.

[2] Babcock, S. M., Wisconsin Research Bull. No. 22, Wis. Agric. Expt. Sta., pp. 88–89.

continue and death follows. This is well shown in the destruction of the bean weevil larvæ, and the pupal stages of the Hessian fly[1] by drought.

Continued exposure to moist air does not seem to produce death directly but rather to encourage digestive troubles[2] and to supply the conditions for the destructive growth of parasitic fungi as was the case with the third test of the bean weevil.

Naturally, the inability of the bean weevil to reproduce in moisture of 26 per cent and below led to an examination of dry air as a means of sterilizing and preserving bean seeds from weevil injury.

The first set of experiments, which bore at all on this point, were laid out for an entirely different purpose, but the data from them bears on this matter sufficiently to justify their introduction. Five glass museum jars each with a capacity of one liter were selected and into the first was poured 250 cc. of concentrated sulphuric acid of specific gravity 1.83, into the second a mixture of 125 cc. of distilled water and 125 cc. of concentrated sulphuric acid, into the third a mixture of 83 cc. of acid and 167 cc. of water, into the fourth 250 cc. of distilled water and into the fifth nothing whatever. Into each of five wide-mouthed two-ounce bottles were introduced enough white beans to cover the bottom, and 25 healthy specimens of the bean weevil. The mouth of each bottle was covered with gauze and the bottle suspended from the inside of the glass cover which was then clamped on the jar on a rubber gasket.

In slightly more than one month after the experiment started the jars were opened and the beans examined. In the jar having 250 cc. of acid all weevils were dead and the beans free from injury. In the jar having 125 cc. of acid and 125 cc. of water the same condition was found. In the jar having 83 cc. of acid and 167 cc. of water living beetles of the second brood were found and many of the beans had been perforated. In the jar having 250 cc. of distilled water both weevils and beans were destroyed by fungi. In the jar having air only, a large brood of second brood beetles were found and most of the beans were perforated.

It thus appears that reproduction of the weevil in tightly closed jars can be prevented by the introduction of sufficient concentrated sulphuric acid to keep the atmospheric humidity low.

The second experiment relative to the utilization of a dry atmosphere to destroy bean weevil was planned for that specific purpose. Ten glass museum jars each of one liter capacity were chosen and a two-

[1] Headlee, Thos. J., and Parker, J. B., L. c., p. 108–109.

[2] Standfuss, M., Handbuch für Sammler der europäischen Gross-Schmetterlinge, 1891.

ounce bottle furnished with beans and weevils as described in the first experiment suspended from the inside of each lid. In jar No. 1 .01 cc. of concentrated sulphuric acid (sp. gr. 1.83) was placed, in jar No. 2, .03 cc., in jar No. 3 .05 cc., in jar No. 4 .1 cc., in jar No. 5 .25 cc., in jar No. 6 .5 cc., in jar No. 7 1 cc., in jar No. 8 5 cc., in jar No. 9 10 cc., and in jar No. 10 nothing whatever. The lids were set in place and clamped down on rubber gaskets.

The experiment was started August 30, 1916, and discontinued December 12, 1916.

TABLE SHOWING THE EFFECT OF A DRY ATMOSPHERE ON THE BEAN WEEVIL

| Treatment | Total number of beans | Total number of holes | Number of holes per bean |
|---|---|---|---|
| .01 cc. of $H_2SO_4$ (sp. gr. 1.83) | 36 | 163 | 4.5 |
| .03 cc. of $H_2SO_4$ (sp. gr. 1.83) | 26 | 43 | 1.6 |
| .05 cc. of $H_2SO_4$ (sp. gr. 1.83) | 20 | 158 | 7.9 |
| .10 cc. of $H_2SO_4$ (sp. gr. 1.83) | 23 | 230 | 10. |
| .25 cc. of $H_2SO_4$ (sp. gr. 1.83) | 24 | 116 | 4.5 |
| .5 cc. of $H_2SO_4$ (sp. gr. 1.83) | 22 | 61 | 2.7 |
| 1 cc. of $H_2SO_4$ (sp. gr. 1.83) | 26 | 54 | 2.0 |
| 5 cc. of $H_2SO_4$ (sp. gr. 1.83) | 22 | 00 | 0.0 |
| 10 cc. of $H_2SO_4$ (sp. gr. 1.83) | 134 | 00 | 0.1 |
| Nothing | 35 | 236 | |

Thus we see that in a sealed chamber about 5 cc. of concentrated sulphuric acid per 1,000 cc. of air prevents reproduction when a limited number of beans is used. The amount will have to be increased in proportion to the moisture which the bean can give off.

The next step was to determine whether the viability of the beans had been injured by the exposure to dry air, and a germination test was undertaken with the following results. The period of exposure was 92 days.

TABLE SHOWING THE EFFECT OF DRY AIR ON VIABILITY OF BEAN SEED

| Treatment | Total No. of beans | No. which germinated | Per cent which germinated |
|---|---|---|---|
| Control | 35 | 32 | 91.4 |
| 5 cc. $H_2SO_4$ (sp. gr. 1.83) | 23 | 19 | 86.3 |
| 10 cc. $H_2SO_4$ (sp. gr. 1.83) | 34 | 27 | 79.4 |

It thus appears that prolonged exposure of 92 days results in injury. It should be remembered that the period required for sterilization does not exceed 30 days, and that in view of the small amount of harm of even the prolonged exposure, a period of the necessary length would not injure the viability in the least.

In this connection it is interesting to note that Chambers[1] relates a native method of protecting maize from weevils by mixing the grain with finely powdered wood ashes. He notes that a layer of wood ashes on the outside of the sack alone is effective. The editor[2] of the publication in which Chamber's article appears states that a layer of building lime on the floor of the storing place and between successive layers of bags gives satisfactory results. While one would normally attribute these results to the caustic effect of the ashes or lime, the fact that the substance appears to protect even when not in direct contact when taken with the well known hygroscopic qualities of ashes and lime leads one to suspect that here we have the practical application of the effect of low relative humidity.

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Adjournment.

*Afternoon Session, Thursday, December 28, 1916, 2 p. m.*

VICE-PRESIDENT G. A. DEAN: The Association will please come to order. The first paper on the program will be read by Mr. C. H. Hadley, Jr.

## THE SEVENTEEN-YEAR LOCUST IN WESTERN NEW YORK

By C. H. HADLEY, JR., and R. MATHESON

During the summer of the year 1916, the periodical cicada or "seventeen-year locust," *Tibicen septendecim*, appeared in varying numbers in several counties in western New York. This brood, brood VII of Marlatt's nomenclature (brood XIX of Riley's nomenclature), last appeared in New York in the year 1899, and was reported by Lowe[3] and Felt[4] as having occurred in Monroe, Livingston, Ontario, Yates, Cayuga, Madison and Onondaga Counties.

The following notes of the occurrence of these insects during the past summer, incomplete as they are, are presented as a matter of record.

LIVINGSTON COUNTY—On June 22, the insects were found in large numbers in Sonyea, on the grounds of the Craig Colony for Epileptics. One colony was in a grove of young oak trees covering ten or more

[1] Chambers, F., A Defence against Weevils, Rhodesia Agric. Jl., Salisbury, XIII, No. 3, June, 1916, pp. 397–398. Taken from Rev. of App. Ent., Vol. IV, ser. A., pt. 9, p. 391.

[2] l. c., p. 391.

[3] Lowe, V. H., Bulletin 212, N. Y. (Geneva) Agri. Exp. Sta., 1902.

[4] Felt, E. P., 15th Report, N. Y. State Ent., 1899.

acres, from which the insects had scattered into nearby woodlands. At places the emergence holes were very abundant, as many as forty or more having been counted in a square foot in various places. It was stated that the insects had first been observed early in the month. At this date, June 22, very few egg punctures could be found and only occasionally were females found in the act of ovipositing. Mating pairs were common.

The other colony was found a few miles away from that mentioned above, covering at least 100 acres of the woodland. Apparently the cicadas had been even more abundant in this place, as the exit holes were very much more numerous. A road had been run through these woods within a few years, and emergence holes were common in the bed and along the sides of this road. In this colony, which was examined on June 23, egg laying seemed to be more advanced, as many females were observed in the act of ovipositing, and almost all of the bushes and smaller branches of the trees showed numerous egg punctures.

It was stated that the locusts had also appeared near Geneseo, in Livingston County.

Mr. H. H. Knight informed the writers that he found this species in some numbers at Conesus Lake.

Ontario County—At Holcomb, the cicadas were exceedingly abundant on the farms of F. E. Burt and Henry Chapin, covering over 200 acres of orchards and woodland. The writers were told that this was the third successive appearance of the insects in part of the orchard to be observed by Mr. Chapin himself. The ground throughout the whole orchard was literally riddled by the emergence holes of the cicadas. Mr. Burt's orchards, just across the road, presented a similar appearance. It was stated that the insects appeared during the first week of June. At the time of the writers' first visit to this place, June 24, the insects had apparently just commenced egg laying, and were abundant on both old and young apple trees and in a young cherry orchard located between the old and young apple orchards. At the time of the writers' second visit, June 29, egg laying was in full sway. Comparatively little damage was done in the old apple orchard, but the young apple orchard, comprising about ten acres of Rome Beauty trees, set the previous year, was entirely destroyed. Many of the trees were dead on this date, and it is doubtful if a single tree survived the attack. The cherry orchard previously mentioned seemed to suffer little injury, as relatively few locusts were present, and scarcely any egg punctures could be found.

It was stated that the locusts had appeared at irregular intervals along a distance of ten miles in that vicinity, including the towns of Victor, Holcomb, Bloomfield, and East Bloomfield.

On June 25, a few locusts and their emergence holes were observed in the district about Padelsford and Martensia, but not in excessive numbers.

On June 21, the senior writer spent the day in the vicinity of Manchester and Shortsville, but was unable to find any traces of the insect. No report of any outbreaks had been heard of in either village, so far as could be ascertained. Lowe reported the insects as having occurred at Manchester in 1899.

Specimens were also received from correspondents in East Onondaga, Onondaga County.

Several individuals of this species were taken at Lake Ridge, Tompkins County, on June 16, 1916. Mr. Benjamin, who collected the insects, informs us that they were abundant over a district about ten miles in length and several miles in width of which Lake Ridge seemed to be the center.

It may be noted that in no case were any of the so-called "cicada turrets" observed, among the thousands of exit holes seen by the writer.

The writers are indebted to Professor P. J. Parrott for the following additional records of the occurrence of the insect:

Livingston County—Groveland.
Ontario County—Billsboro and Ionia.
Onondaga County—Onondaga Valley.
Yates County—Dresden and Earls.
Monroe County—West Webster.

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VICE-PRESIDENT G. A. DEAN: Is there any discussion?

MR. P. J. PARROTT: I am very much interested in this paper presented by Mr. Hadley. While we did not devote much time to the study of the insect, our attention was called in several instances to large numbers of Cicadas in apple orchards. The occurrence of the species in old apple orchards is certainly deserving of mention. At the time Mr. Hadley was watching the insects in orchards about Holcomb, we evidently were similarly occupied in orchards to the north of this locality in the region of Victor. Here there are many old orchards and the opinion generally prevailed that this was the third visitation by the insects. We made several trips to this locality to note the times of appearance of the different stages and the work of the adults on apple wood. In some old apple orchards the insects were present by tens of thousands, and in one orchard neighboring farmers were summoned to destroy the nymphs as they ascended the trees. We noted oviposition on peach and apple. On account of the large numbers of Cicadas that made their appearance on fruit trees we were able

to carry on a spraying test with Bordeaux mixture, to which was added a large amount of lime—60 to 80 pounds to 100 gallons of the mixture. In this connection it is of interest to note that the spraying did not apparently deter the insects from ovipositing.

VICE-PRESIDENT G. A. DEAN: If there is no further discussion, we will listen to the next paper by Mr. J. J. Davis.

## A CHEMICAL FEEDING ANALYSIS OF WHITE GRUBS AND MAY-BEETLES (LACHNOSTERNA) AND ITS ECONOMIC APPLICATION[1]

By JOHN J. DAVIS, *West Lafayette, Indiana*

The practice of hogging off corn, thereby saving the labor and expense of harvesting and marketing the crop and producing more pork from the crop, is becoming a common farm practice and the value of this procedure has been demonstrated by federal and state investigators. However, the additional value and utilization of hogs for the destruction of soil-inhabiting insect pests, more especially white grubs and cutworms, has been given but little attention and seldom consistently applied, although pasturing hogs in grub-infested fields has been more or less practised for the past hundred years.

Their fondness for white grubs is well known, being evidenced wherever unringed hogs have been turned into pastures and their utilization for the eradication of grubs has been excellently shown by Dr. S. A. Forbes who reports[2] the destruction of 99 per cent of the grubs in a ten-acre, badly infested cornfield after being pastured for twenty-seven days with 100 pigs and 8 sows.

Notwithstanding these demonstrations, farmers have been slow in making use of hogs for the control of grubs, largely because their fields are not hog-tight and it therefore becomes necessary to prove the practicability and profitableness of the practice beyond the simple eradication of insect pests. Consequently a chemical feeding analysis of the grubs and May-beetles was made by Messrs. C. Cutler, J. H. Roop and M. S. Libbert, through the coöperation and courtesy of Mr. W. J. Jones, state chemist of Indiana.

The analyses as furnished us by Mr. Jones, which were made from one- and two-year-old grubs and recently matured adults, respectively, collected in the fall of 1916 behind plows, together with the analysis of dent corn as given by W. A. Henry,[3] follow:

[1] Published by permission of the Secretary of Agriculture.

[2] On the life-history, habits and economic relations of the white grubs and May-beetles. Bul. Ill. Agr. Expt. Sta., No. 116, Aug. 1907, p. 478.

[3] Feeds and Feeding, 1910.

| Sample No. / Material | Z–23 *Lachnosterna* grubs | Z–24 *Lachnosterna* adults | Corn |
|---|---|---|---|
| Moisture per cent | 79.9 | 69.4 | 10.6 |
| Crude fat per cent | 3.1 | 4.9 | 5.0 |
| Crude protein per cent | 11.1 | 20.1 | 10.3 |
| Crude fiber per cent | 1.6 | 3.7 | 2.2 |
| Crude ash per cent | 2.0 | 1.6 | 1.5 |
| Nitrogen free extract per cent | 2.3 | 0.3 | 70.4 |

Comparing with other feeds the fat and protein contents of the grubs compare favorably with these constituents in corn, as indicated above, but the carbohydrates are deficient, indicating that feeding corn in connection with pasturing hogs in grub-infested land or, better, pasturing hogs in such land having a stand of corn, is desirable and a good practice.

To our knowledge only one chemical analysis of May-beetles has been published and this analysis (of *Melolontha vulgaris*) which was made by Stöckhardt in the Academy of Forestry of Tharand in 1856 to determine their fertilizer value and published by Lunardoni [1] is herewith given for comparison.

| Material | Fresh May-beetles | Dried May-beetles |
|---|---|---|
| Nitrogen | 3.23 | 9.6 |
| Fat | 3.80 | 11.5 |
| Other organic substances | 24.77 | 74.7 |
| Mineral substances formed especially out of the components of phosphoric acid $K_3PO_4$, $K_2CO_3$, and $C_2P_2O_8$) | 1.40 | 4.2 |
| Water | 66.80 | 0.0 |
| Total | 100.00 | 100.00 |

Reducing to similar terms, the above analysis, made over half a century ago, compares favorably with our analysis of May-beetles, as follows:

| Material | *Lachnosterna* adults | *Melolontha* adults |
|---|---|---|
| Nitrogen | 3.22[2] | 3.23 |
| Fat | 4.9 | 3.80 |
| Other organic substances | 20.88 | 24.77 |
| Ash | 1.6 | 1.40 |
| Water | 69.4 | 66.80 |
| Total | 100.00 | 100.00 |

In the white grub infested areas there is an average of 106,680 grubs per acre. The grubs during the fall of their destructive season aver-

[1] Agostino Lunardoni, Gli Insetti Nocivi. *In* La Scienza e la Pratica Dell' Agricoltura, vol. XI, 1899, pp. 119–157.

[2] The nitrogen content in the protein.

age one gram each and the beetles slightly less, so that each infested acre contains approximately 235 pounds of grubs which have a food value of more than $3, that is, $30 for ten acres, enough to pay for fencing the field with hog-tight wire. In addition to the value of the grubs as hog feed the value of the manure produced should also be considered. In his bulletin, "The Growing and Fattening of Hogs in the Dry Lot and on Forage Crops,"[1] Prof. E. S. Good quotes Dr. H. S. Grindley as authority for the information that 85 per cent of the fertilizing constituents taken in by hogs as food is eliminated in the urine and feces for the entire life of the animal, being greater for mature individuals. In other words, 8½ pounds of nitrogen is given off in the manure for each 10 pounds taken in as food and approximately 3.56 pounds of nitrogen alone would be given off in the manure produced by grubs eaten from one acre of ground, or 4.38 pounds if beetles were eaten.

To further illustrate the fertilizer value of the grubs it may be noted that the nitrogen content contained in the protein is 1.78 per cent of the entire analysis in the case of the grubs and 3.22 per cent in the case of the beetles and in addition the ash is heavy in phosphoric acid although the exact amount has not been ascertained.

Three objections have been raised to the use of hogs in grub-infested ground, especially in the case of pastures, namely, lack of hog-tight fences, rooting up of pasture land, and possible infestation with the giant thorn-headed worm, an intestinal worm affecting hogs. The first objection has already been answered. Observations indicate that an infested pasture, although badly overturned by rooting hogs, reseeds itself the following season with no ill effect other than a roughing of the surface which is of little significance. The last objection relative to possible infestation with the giant thorn-headed worm (*Gigantorhynchus hirudinaceus* = *Echinorhynchus gigas*) is of considerable importance. The white grub is an intermediate host of this worm which seems capable of entering hogs only by being taken into the body with grubs eaten. However, as a rule, no trouble will result from these worms if hogs which have never been pastured are used in fields which have not been previously pastured with hogs within three years. Care should be taken to prevent brood sows from running in fields likely to contain grubs infested with thorn-headed worms, that is in fields which have not been hog-pastured the previous season or two, but hogs being fed for market, according to our observations, can, with possible exceptions of very young pigs, be pastured with less regard for the past history of the field since they are usually marketed before the effect of the worms, if any are present, become harmful.

[1] Bul. Ky. Agric. Exp. Sta. No. 175, Apr. 1915, p. 332.

The advantages of pasturing hogs in grub-infested land in addition to the advantages advanced by swine experts regarding ordinary pasturing of hogs may be summarised as: 1. Eradication of grubs which might otherwise destroy the crops planted on the ground. 2. Value of the grubs as hog feed which is comparable with feeds costing $25 to $35 per ton. 3. Value of the manure distributed over the land, which has a money value, according to the experts of the Federal Bureau of Animal Industry,[1] of $3.29 per ton.

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VICE-PRESIDENT G. A. DEAN: Is there any discussion?

MR. G. W. HERRICK: I would like to ask Mr. Davis if the adults have been fed to hogs.

MR. J. J. DAVIS: Only when they are found in infested fields; that is, during the fall of the year that they change to beetles. Hogs will search for beetles in the soil just as freely as for grubs.

MR. G. W. HERRICK: Were there any poisonous effects?

MR. J. J. DAVIS: Absolutely no poisonous effects to my knowledge.

MR. H. E. SMITH: The table shows a high content of crude protein. Has anything been done about determining the digestible protein content. That is what the farmers are interested in as it is a most important factor, and a statement of crude protein is likely to be misleading.

MR. J. J. DAVIS: I cannot answer that. All feeding materials are analyzed in this way and the protein content spoken of as crude protein. Apparently the digestible protein content cannot be determined by a feeding experiment. I might add a word relative to the non-injurious effects of the grubs on hogs. Dr. Forbes in one of his bulletins records pasturing 108 hogs in an enclosed 10 acre field badly infested with white grubs. In 27 days less than 1% of the grubs remained. If we figure 34.6 grubs per hill, the count made at the beginning of the experiment, it is easily calculated that the pigs destroyed approximately 1,217,083 grubs in 27 days. That is 11,278 or possibly 24 pounds per animal which, by the way, suffered no ill effects from this large amount of grubs.

MR. G. W. HERRICK: The reason I asked was that some experiments in feeding rose bugs proved poisonous to chickens and I did not know but what similar results might occur in feeding May-beetles.

MR. J. J. DAVIS: No poisonous effect has ever been noticed from feeding Lachnosterna beetles to hogs or chickens to my knowledge.

VICE-PRESIDENT G. A. DEAN: Mr. Joseph H. Merrill will now present the next paper.

[1] Weekly News Letter, U. S. Dept. Agr., vol. IV, No. 17, Nov. 29, 1916, p. 3.

1. Blight canker containing aphid eggs.
2. Method of caging aphids on twigs.
3. Check twig on left; blighted twig on right.
4. Blighted twig.

# FURTHER DATA ON THE RELATION BETWEEN APHIDS AND FIRE BLIGHT (BACILLUS AMYLOVORUS BUR. TREV.)[1]

By J. H. MERRILL, *Assistant Entomologist, Kansas Agricultural Experiment Station*

In the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 8, No. 4, 1915, a report was given of field observations made on the relation of aphids to fire-blight in Doniphan County, Kansas, for the years 1913, 1914 and 1915. In 1915 and 1916, observations were carried on in Atchison as well as in Doniphan County, and in both counties a direct relation was found to exist between the severity of the aphid infestation and the amount of fire-blight infection.

It was planned to carry on experiments during the spring and summer of 1916 to determine two points—(1) how it was possible for the aphids to come in contact with the blight bacteria, and (2), whether or not the aphids could inoculate trees with fire-blight.

To determine the first point, a large number of hold-over cankers were examined and it was found that the aphids deposited their eggs in blight cankers (Pl. 2, Fig. 1) as readily as in any rough places on the bark. In the spring, the live cankers resume activity, giving forth gummy exudations filled with bacteria. The aphids, which hatch from eggs laid in the cankers, crawl through these exudations in passing to the terminal growth of the twigs and, in so doing, become contaminated with blight bacteria.

To determine the second point, it was planned to secure a large number of aphids, allow them to pass over pure cultures of blight bacteria, and then transfer them to the twigs of apple trees. Owing to the fact that aphids were very scarce in Kansas during the summer of 1916, none were obtained for this work until August.

During the month of August, the average maximum temperature at the field insectary at Manhattan, where these experiments were being conducted, was 96.5 degrees and the total rainfall for the month was .71 of an inch. Naturally, the trees put forth but very little new growth during this period.

Despite these adverse weather conditions, aphids, which had previously passed over pure cultures of blight bacteria, were placed on the twigs of four Yellow Transparent trees and these twigs covered with cheesecloth bags (Pl. 2, Fig. 2) to prevent other insects gaining access to

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 21. This paper embodies the results of the investigations undertaken by the author in the prosecution of project No. 13. Kansas Agricultural Experiment Station.

them. On the same date, transfers were made by a sterile needle from a pure culture of the organism to lesions in the succulent growth of several other twigs. Although observations were made on all of these trees until the 13th of October, no traces of blight were noticed. On the 25th of August, infected aphids were placed on four Yellow Transparent and four Jonathan trees, but the results were similar to the first experiment.

During the month of September, the average maximum temperature was 80.3° and the total rainfall was 8.12 inches. The apple trees now began to put forth new, tender growth, producing conditions more nearly approximating those of spring when blight is ordinarily more prevalent.

On the 25th of September, infected aphids were placed on nine Yellow Transparent, two Jonathan, one Delicious, one Winesap, and one Ben Davis apple trees. Although brown spots appeared on the leaves and terminal buds of some of the Yellow Transparent trees, no clear cases of blight were discovered. On the 7th of October, the Jonathans began to exhibit signs of blight, which became well developed cases by the 10th of October. The other varieties did not blight.

During the first thirteen days of October, while observations were being made on these trials, the average maximum temperature was 77 degrees and the total rainfall for that period was .9 of an inch. The apple trees developed considerable new growth during the early part of the month. On the 3d of October, infected aphids were placed on three Jonathan and four Yellow Transparent trees. The blight made its appearance on October 5 when the leaves began to turn brown, increasing daily until, on the 13th of October, all of the twigs showed well-developed cases of fire-blight (Pl. 2, Figs. 3 and 4).

## Summary

1. The blight developed only in the tender succulent growth on the twigs.

2. By hatching from eggs laid in blight cankers, the aphids come in contact with the fire-blight organism.

3. Aphids can and do inoculate trees with the bacteria of fire-blight.

4. The amount of fire-blight infection in an orchard may be materially decreased by destroying all of the aphids which may appear there.

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Vice-President G. A. Dean: This paper is now open for discussion.

Mr. M. T. Smulyan: I would like to ask what species of aphids were utilized in these experiments.

Mr. J. H. Merrill: Green.

MR. M. T. SMULYAN: I would like to ask if any other species were used.

MR. J. H. MERRILL: Those were the only ones I was able to get this year.

MR. M. T. SMULYAN: You cannot say then what species is most responsible for carrying the blight.

MR. J. H. MERRILL: In Kansas the blight cankers resume their activity just before the trees leave out in the spring, and at that time it is the green aphis which is present and enters the buds as they open and works its way into them. They may very easily inoculate the trees with the blossom blight by so doing.

VICE-PRESIDENT G. A. DEAN: If there is no further discussion, we will listen to the next paper by Mr. Quincy S. Lowry.

## AN OUTBREAK OF THE EIGHT-SPOTTED FORESTER, ALYPIA OCTOMACULATA FABR., IN NEW HAVEN, CONN.

By QUINCY S. LOWRY, *New Haven, Conn.*

On July 22, 1916, the writer, by request, visited the estate of Mr. E. A. Prince at 498 Howard Avenue, New Haven, to inspect his grape arbors which were being rapidly defoliated. Thousands of caterpillars, mostly full grown, were found feeding on nearly all kinds of foliage in the yard, but were especially abundant upon the grape and Virginia creeper. These proved to be larvæ of the Eight-Spotted Forester, *Alypia octomaculata* Fabr.

Due to the fact that this is a common insect, no detailed description is necessary here. It might be stated that it is a conspicuous naked caterpillar, the head being yellow, dotted with black, the segments rather brilliantly marked crosswise with orange, black, and white bands, each segment also having a row of black dots. There is near the tail a rather prominent hump on each side of which is a light yellow spot, rhomboidal in shape; smaller yellow irregular lateral markings are noticeable just above the spiracles and between the orange cross-bands. The full grown larvæ are about one and one-half inches in length.

The grape is the favorite food of this species, though it feeds readily on Virginia creeper, *Ampelopsis quinquefolia* Michx. The larvæ were also found feeding on the common barberry, *Berberis vulgaris* Linn., and different varieties of rose.

Nothing had been done up to this time (July 22) to prevent the ravages of the caterpillars and there was scarcely any food available, the arbors and also the Virginia creepers being completely defoliated.

Mr. Prince had a Virginia creeper which was used as a screen and covered the entire end of the piazza, which did not have a leaf on it at this date. The new clusters of fruit on the grape arbors were badly eaten as well as the foliage.

A great many larvæ were collected and brought to the laboratory, but the majority of these did not live. Consequently, more larvæ were collected from the same locality on July 28. As Mr. Prince had sprayed everything on his premises with arsenate of lead, which proved to be most effective, it was difficult to find any living larvæ, though plenty were present in adjoining yards.

All of the arbors within a radius of a mile were in the same general condition. However, outside of this district there was no other complaint made in Connecticut. It seems to be a well-established fact that this insect is rarely found in vineyards or arbors located in the country, but only in the city yards. At the Experiment Station farm, located at Mt. Carmel, a grape arbor was inspected several times and no trace of the Eight-Spotted Forester found; neither had there been any complaint from nearby towns such as Yalesville and Meriden where there are several vineyards.

On August 2, the majority of the larvæ collected on July 28 had gone into the sand in the breeding cages. The adult moth will not emerge until spring. The wings are velvety-black and have two large pale yellow spots on the forewings and two smaller white spots on the hind wings. The first and third pair of legs are tufted with orange.

Two Tachinid parasites emerged August 15, and were identified by Mr. Harrison E. Smith of the Bureau of Entomology as being *Winthemia quadripustulata* Fabr. It is a question as to whether this insect will cause damage in the same locality another year, and also if the parasites will keep it in check.

The writer has been unable to find any publication which figures the Eight-Spotted Forester as being of much economic importance, and only brief accounts of this insect have been published recently, all of which simply mention it as feeding on grape and Virginia creeper. It seems from the outbreak in New Haven, that considerable damage and financial loss would be caused if this insect became abundant in a commercial vineyard.

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VICE-PRESIDENT G. A. DEAN: The next paper will be read by Mr. George G. Becker.

# NOTES ON THE PEACH-TREE BORER (SANNINOIDEA EXITIOSA)

By Geo. G. Becker, *Fayetteville, Ark.*

Before taking up the subject of this paper the writer wishes to make acknowledgments to Messrs. W. C. Quick, W. D. Merrill and William Lee, who, as student assistants under his direction, made a great many of the observations recorded in this paper.

Most of the notes are made on pupation, and on the emergence and habits of the moths.

## Pupation

Attempts were made to ascertain the time required in spinning up, the time spent as larva in the cocoon and the time spent in the cocoon in the actual pupal stage. The problem was fraught with some difficulties and the data here offered are at best more or less fragmentary.

As long as four days may be required to construct a cocoon, though it appears that with average larvæ this does not require more than a day.

After spinning up in its cocoon the larva remains in this stage for a period of 5 to 9 days. During this time it doubtless works for a day or so finishing up the interior of its cocoon and then rests awhile before transforming to the pupal stage. We had one larva spin its cocoon and transform to the pupal stage in six days.

The duration of the pupal stage within the cocoon appears to be about three weeks, though here again there seems to be a variation with individuals. One individual which was observed as a tender white recently transformed pupa emerged 13 days later as an adult, thus requiring only 13 days for its pupal stage. Our observations lead us to the conclusion that the time which elapses from the time that the larva spins its cocoon to the time that the moth emerges ranges from 18 to 30 days.

## Emergence

Emergence from the pupal stage was watched with considerable interest and from the observations of 1916, which need to be verified, it appeared that there were four stages of emergence.

Emergence occurred from 6 to 10 a. m., but was apparently most active from 8.30 to 9 on bright clear days. Doubtless this would vary with the time of the year when emergence took place, being earlier on long days than on the shorter and cooler days later in the season.

Atmospheric and light conditions seemed to be the factors governing emergence after the pupæ were mature for the transformation, though light seemed to be the more important.

In the case of pupæ kept under cover in the insectary it was found that darkness retarded emergence. On a day when it was raining at intervals, moths were observed emerging with the sunny spells when the inverted box was removed from over them.

A pupa which was at the stage ready for pupation, was brought into the laboratory and induced to emerge by subjecting it to the rays of an arc light.

### Stages of Emergence

Stage 1. It was observed in the case of pupæ which would emerge on a certain day that there was a small tear across the top of the cocoon which indicated in advance which ones would be likely to emerge that day. Pupæ having such a tear would likely emerge that day though unfavorable weather conditions would cause emergence to be postponed until conditions were again favorable. When a tear was not observed until after the normal time of emergence the insect would not pupate until the next day.

Stage 2. If one will observe a pupa, as described for stage 1, at the right time (8 to 9 a. m.) on a clear day, the rift across the top of the pupal case will be observed to suddenly widen and the pupa will be seen pushing steadily out of the case until it is about one-third way out. This only requires on an average about 2½ minutes. Following this the pupa rests for a period of about twenty minutes before undertaking the next stage of its emergence.

Stage 3. Following this rest comes another pushing upward frequently accompanied by a sort of circular, twisting movement. By this time the pupa has pushed itself from one-half to two-thirds way out of its case. Frequently when they have gotten on this far pupæ will be observed going through this circular, twisting movement which Cory noted in his observations. In doing this a pupa may twist itself out of its cocoon, in which case emergence from the pupal skin seems to be difficult. The second stage of emergence requires about five minutes.

Stage 4. The pupa rests only a few seconds after it is two-thirds way out of its case and then starts to push through its pupal skin. One may observe through the pupal skin that all the body seems to be crowded forward in order to exert as much pressure as possible on the back of the thorax. In the case of females the bright orange band on the abdomen will be observed to move one segment forward under the pupal skin. Suddenly the skin splits over the thorax and the top of the meso- and meta-thorax pushes out, followed by the head. The antennæ are then drawn out and are almost immediately followed by the prothoracic legs. This done, the pressure seems to be released and the insect has apparently no difficulty in wriggling out of the skin.

The process of emergence, once the skin is split, requires only 20–35 seconds. After emergence the insect crawls up on top of its deserted pupal skin, on the trunk of a tree or clod of dirt. At this stage the wings are plastered down on the back. In about 15 minutes the wings begin to raise up off the body and have the appearance of becoming inflated. This requires several minutes. During this the wings gradually straighten out and assume shape. Following this they are waved a time or two and are then held vertically over the back for about five minutes. They are then brought down over the back as in the normal insect when at rest and in about twenty minutes, in the case of the moths which we observed, the insect is ready for flight.

## Date of Emergence

Records on the date of emergence yielded some interesting results and suggested a line of investigation which might bring some interesting facts to light if it could be interpreted with careful temperature, humidity and other climatological records.

The records were made by going over the same orchard at intervals of three to seven days and collecting all the pupal skins which appeared around the bases of the trees since the last observations. All rubbish, etc., was cleared from around each tree before the first observation was made. Pupal skins collected at each observation would then indicate the number of moths which had emerged since the last observation.

Since practically all of the borers pupate either right at, or within a radius of two inches of the tree and since the pupal skins are usually held fast to the cocoon for some time after emergence, it would be possible to get a rather accurate record of emergence.

Regarding the pupation of the insect and their emergence with reference to the tree, the following data on 258 insects are offered:

| | No. | Per cent |
|---|---|---|
| Pupated and emerged from trunk of tree | 5 | 2. |
| Pupated in and emerged from soil immediately against tree | 102 | 39.5 |
| Pupated in and emerged from soil within a radius of 1 inch from trunk of tree | 114 | 44. |
| Pupated in and emerged from soil within a radius of 1 to 2 inches from trunk of tree | 22 | 8.5 |
| Pupated in and emerged from soil within a radius of 2 to 3 inches from trunk of tree | 8 | 3. |
| Pupated in and emerged from soil within a radius of 3 to 4 inches from trunk of tree | 5 | 2. |
| Pupated in and emerged from soil at a distance of 6 inches from trunk of tree | 1 | .5 |
| Pupated in and emerged from soil at a distance of 8 inches from trunk of tree | 1 | .5 |

A study of our date of emergence records indicates that in the Ozarks adults may be on wing any time from the last of May to the last of October. In 1911 a ♂ moth was seen on wing in the orchard on the 29th of May and in 1912 four moths of the 284 recorded in that year's records emerged from October 26–30. In general, however, it will be noticed from the data that 60 to 93 per cent of the emergence takes place within a period of about four weeks—from the middle of August to the middle of September. Before this period emergence is light and sporadic and after this period there are only a few stragglers.

1910. In the records of this year on 350 insects there was a slow and sporadic emergence up until August 23. An interesting rise occurred however, from July 23 to August 5, during which time 25.1 per cent. of the emergence of the season occurred. This rise seemed abnormal, and it was at first thought that there might be two broods of borers concerned in this orchard. A study of the 1912 and 1913 data, taken in the same orchard, would hardly bear this out.

After this brief rise emergence dropped off until August 23 when it began to rise abruptly. Within the week following August 23, 27.1 per cent of the emergence occurred and from September 1 to 20, 54.3 per cent of the moths emerged. After this date emergence dropped off abruptly.

1911. The data of this year is very meagre and was taken from a different orchard, from which only 63 moths emerged; 48.1 per cent of these emerged from August 23 to September 4, emergence being heaviest from August 29 to September 4.

1912. Our records of this year are on 284 skins collected from July 1 to October 30. Emergence was irregular and scattered until August 23 with a slight rise from August 1 to 7, inclusive. From August 23–26 only four moths emerged, but within the next three days there was a rapid rise, 34 moths having emerged, and in the three days following this, August 26–29, sixty-nine moths emerged. The record illustrates well how rapidly emergence rises, it being 4, 23 and 69 at three-day intervals from August 23. The active period of emergence for this year was from August 27 to September 16, during which time 79.5 per cent of the emergence occurred.

1913. Emergence of this year was made on a basis of 405 moths. As in other years there was a scattered and sporadic emergence up until the middle of August. From August 4–11 only two moths emerged, in the week following 25 emerged, in the four days following this, August 17–21, 34 emerged and in the four days following this, August 21–25, 69 emerged. The emergence of this year was characterized by being more concentrated in the period of maximum emergence. This period was steadier and more prolonged than in other

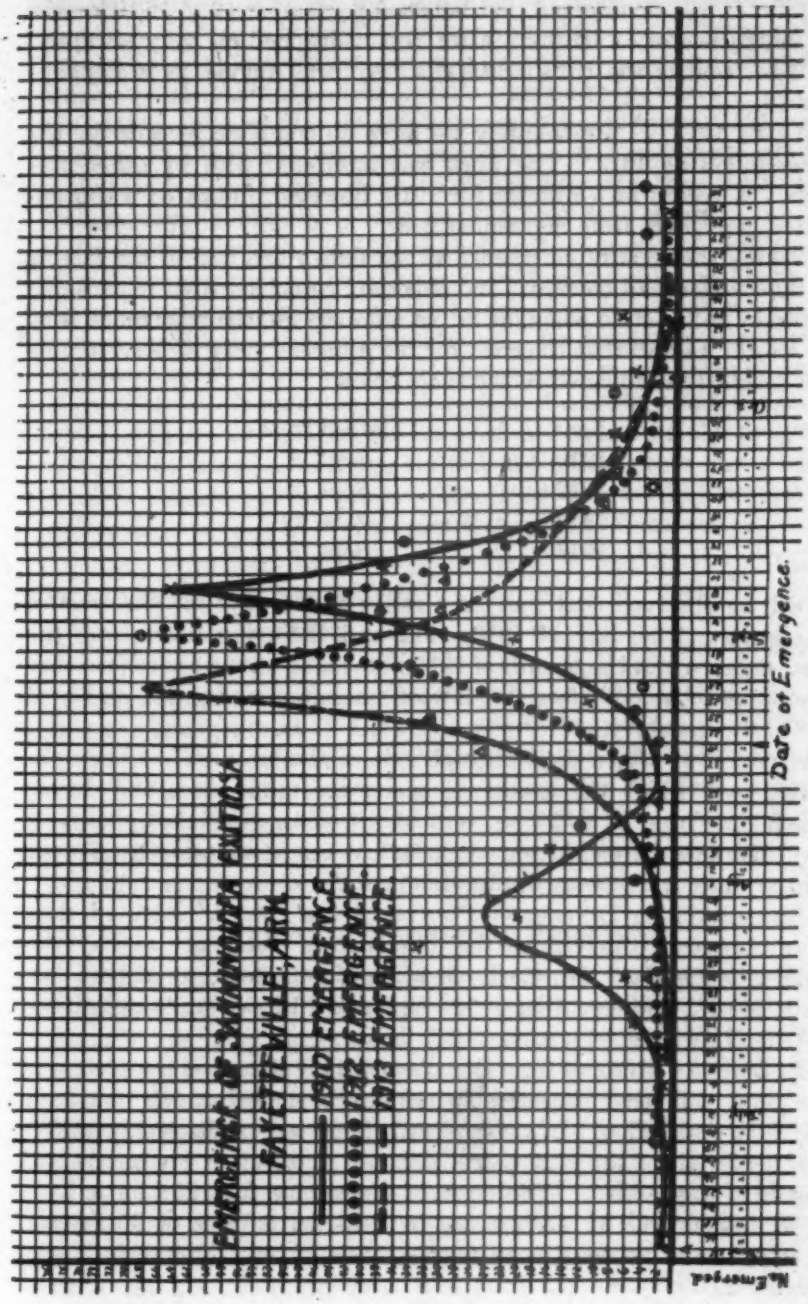


Fig. 1. Emergence of peach borer, *Sanninoidea exitiosa*.

years. It will be observed that between September 12 to 16 there was an emergence of 55 moths. After this it dropped off very abruptly. 93.3 per cent of the 1913 moths emerged from August 18 to September 16.

AFTER 1913. Unfortunately we have no complete records for the years following 1913. The work was interfered with by other projects. A record on 75 moths for 1915, however, indicated a concentrated emergence from September 2–8.

Taking the crest of emergence as the date when half of the insects of that season had emerged, and this date coincided with remarkable accuracy to the date when, as far as numbers go, the emergence is at its zenith, we find that the crest for the different years at Fayetteville was reached as indicated in the table below:

| Year | Date of crest |
|---|---|
| 1910 | Sept. 8 |
| 1912 | Sept. 2 |
| 1913 | Aug. 29 |
| 1915 | Sept. 5 |

It will be observed that there is a range of ten days for the crest of emergence. The data of 1910, 1912 and 1913 was taken from the same orchard, but the records of 1915 were made on the basis of seventy five pupæ collected before the date of maximum emergence, and bred out in the insectary.

A period of fifteen days on each side of the crest will embody the period over which the maximum emergence takes place and during which time from 60 to 93 per cent of the emergence takes place. If the 1910 data be considered abnormal, it might be said that 75 per cent or more will emerge during this period.

EMERGENCE AT DIFFERENT POINTS IN THE STATE. Limited data were obtained to determine the difference in emergence at Fayetteville, latitude of 36° N., at an elevation of 1425 feet; at Abbott, latitude 35° N., and elevation of 580 feet, and El Dorado, Ark., latitude 33° 10′ N., with an elevation of 265 feet.

*El Dorado.* Records from this place are by no means complete and the data will need considerable reinforcement before we can have anything conclusive. In these records pupæ were collected just after practically all of the worms had pupated and before emergence had begun to any extent. The crest of emergence for 1914 on a basis of 62 insects was on August 24, in 1915, on a basis of 69 insects, it was August 26, and in 1916 on a basis of only 22 insects it was August 22.

The data at *Abbott* were procured in the same way as at El Dorado.

On the basis of 29 moths the 1913 crest of emergence was September 7, and in 1914, on a basis of 94, it was August 31. It is not impossible that the change in elevation and, to a lesser extent, latitude, may have influenced the Abbott and El Dorado emergence records.

Getting our records as we did, however, it would appear that emergence at El Dorado is ten days earlier than at Fayetteville, while at Abbott in 1913 emergence was actually ten days later than the Fayetteville average (September 4) and in 1914, four days earlier.

In connection with the 1913 Abbott data it might be well to note that it was made on a basis of only 29 moths and could hardly be considered as representative. The 1914 data was on a basis of 94 moths and is considered more representative. As further evidence of the difference between these different points I find in my notes of August 16 and 18, 1913, made at El Dorado and Abbott, respectively, this note: "From the general condition of the pupæ and the proportion of larvæ to pupæ, indications are that Abbott is about one week behind El Dorado on emergence." The 1914 data would bear this out. Following is a table of comparison of the crests of emergences.

| Location | 1910 | 1912 | 1913 | 1914 | 1915 | 1916 |
|---|---|---|---|---|---|---|
| Fayetteville | Sept. 8 | Sept. 2 | Aug. 29 | ..... | Sept. 5 | ..... |
| Abbott | ..... | ..... | Sept. 7 | Aug. 31 | ..... | ..... |
| El Dorado | ..... | ..... | ..... | Aug. 24 | Aug. 26 | Aug. 22 |

It would seem that we are warranted in concluding from the data that the emergence at El Dorado, a point nearly 3° south of Fayetteville and with a difference in elevation of about 1200 to 1300 feet in favor of Fayetteville, that emergence is certainly one week earlier and probably ten days, while at Abbott, a point 1° south with a difference of 864 feet elevation in favor of Fayetteville, there is enough to suggest that emergence is four days ahead of Fayetteville.

## Annual Variation in Abundance

Although it would appear that the peach tree borer would not be as subject to temperature, humidity and other weather changes as an insect living out in the open, the emergence records of 1910, 1912 and 1913 made from the same trees, show an interesting variation in the number of insects which bred to maturity in these years.

It would seem that this variation would have its explanation to some extent, at least, in a careful study of climatological variations. In this instance the fluctuation may be due to changes on the condition of the trees, rather than on the insect. In 1910 there were 350 insects to breed to maturity in the orchard which was studied. In 1912, 287 bred to maturity and in 1913 there were 405 to breed to maturity.

### Proportion of Males and Females

A little data was accumulated to determine in what proportion the sexes occurred. Following is data which was collected from El Dorado and Abbott material.

| Locality | No. Males | No. Females | Per cent Males | Per cent Females |
|---|---|---|---|---|
| El Dorado, 1913 | 17 | 13 | 56.6 | 43.4 |
| El Dorado, 1914 | 27 | 32 | 45.7 | 54.3 |
| Abbott, 1914 | 34 | 60 | 36.2 | 63.8 |

The data would indicate that males and females usually occur in equal numbers, but that there might be a variation with the season.

### Activities of Moths

Period of Activity. Usually moths are active during the heat of the day. Beginning with emergence as early as 6 a. m. most of them will emerge at from 8 to 9.30 a. m. and by 10 a. m they are usually in coitu. After copulation moths are usually on wing and quite active until about 4 p. m. and by 5 p. m. they are frequently quite sluggish.

Copulation. Moths were observed in coitu, under caged conditions as early as 8 a. m. though the normal time seems to be at 10 a. m. Moths have also been seen in coitu as late as 2.20 p. m. though this is not generally the rule. Copulation in average cases seems to last one hour though we have observed it to last one hour and a half.

Oviposition. In most cases the female begins to oviposit shortly after copulation, but frequently immediately after. Oviposition occurs usually during the warm part of the day, from 10 a. m. to 4 p. m. After this time oviposition drops off. We have observed individuals apparently attempting to oviposit after 5 p. m., but in no case did we actually observe them deposit eggs.

When a female is observed ovipositing she will be seen to wave her ovipositor from one side to the other over the bark. Mr. Lee observed the process of oviposition with a lens and found that the female had fine hairs on the tip of the ovipositor which hairs were in touch with the bark. With these hairs she was able to locate little cavities and irregularities in the bark and in such places she deposited her egg. It is to be noted in this connection that eggs are almost always deposited in little crevices, or, at any rate, not on elevated places of the bark. Frequently the female feels for an egg which she has deposited and deposits another beside it.

The actual act of depositing the egg does not seem to take more than five to ten seconds. A female was timed to see how many eggs she would deposit in a minute. Once she deposited ten eggs, again five, and a third time eight eggs. The number of eggs per minute

depends upon how long it takes the female to find suitable places for her eggs.

Usually a number of eggs are deposited together when they are being deposited on a tree trunk. On leaves, however, they are more frequently deposited singly.

Usually a moth alights at the base of a tree, deposits a few eggs, crawls to the side and deposits a few more, or else they crawl up the trunk, depositing eggs at intervals of one to two inches as they go.

It is of interest to note in this connection that moths seemed to dislike trees which were treated with asphalt. Frequently they shunned such trees and it was observed that they seemed to deposit eggs on the leaves of asphalt treated trees rather than at the base. One moth, however, was observed to deposit eggs in cracks of an asphalt coating.

Moths were found to deposit on trunks, twigs and leaves of peach trees as well as on weeds and clumps of dirt. Mr. Merrill observed one female evidently making repeated and persistent attempts to deposit eggs on the back of a Sphingid larva.

From our observations we concluded that about 50 per cent of the eggs were deposited at the base of the peach tree, 34 per cent a little higher up on the trunk, 3 per cent on twigs, 10 per cent on leaves, 2 per cent on weeds and about 1 per cent on clumps of dirt, etc. These observations were made by following moths around in the orchard and counting the eggs every time they alighted for the purpose of ovipositing. We found it possible to follow moths through as many as five ovipositions. Many times the moths crawled from one part of the tree to the other in order to oviposit, so that records were easily kept in these instances.

Longevity of adults will be discussed at this point so that the number of eggs per female, per cent fertility of the eggs, etc., may be considered together.

In 1913 the average life of females experimented with under caged conditions proved to be 4.3 days. These moths were given neither food nor water, so that this would hardly represent the average life of an adult.

In 1916 moths were kept in cages with sweetened water, and it is believed that the duration of the adult stage under these conditions was nearly normal. Six females, three of which had copulated and three of which had not, lived on an average of 6.3 days. In these cases copulation did not seem to have any effect on the life of the individual.

Seven females, six of which had been fertilized, averaged 7.6 days. One of this number was an unusual moth. She lived 12 days and deposited 1072 eggs.

## Prolificacy

Number of Eggs per Female. In experiments conducted in 1913 with females under caged conditions 8 females averaged 522 eggs. They were not dissected to see if they contained any additional eggs. It was thought that females under caged conditions would not deposit as many eggs as they would in the orchard and dissection of moths in 1916 showed that caged females, after they had died, contained a number of eggs.

Records of three moths made in 1916 yielded the following results:

| | Number of Eggs Deposited | Number of Eggs Dissected | Total |
|---|---|---|---|
| No. 1 | 670 | 141 | 811 |
| No. 2 | 426 | 297 | 723 |
| No. 3 | 1,072 | 8 | 1,080 |
| Average female | 722 | 148 | 871 |

Although the 1916 data is on only a few individuals it would indicate that the number of eggs deposited by a normal female is higher than the 1913 experiments indicated. In the latter case the females were starved and, what is more, they were not dissected for eggs. An expectancy of 800 eggs per female would not seem to be unreasonable.

## Fertile Eggs

Eggs from eight different females were tested to determine what per cent. of deposited eggs were fertile. The results appear in the table which follows:

| No. Insect | No. Eggs Tested | Percent Fertile |
|---|---|---|
| 1 | 517 | 98 |
| 2 | 974 | 98 |
| 3 | 587 | 98 |
| 4 | 358 | 98 |
| 5 | 386 | 96 |
| 6 | 450 | 99 |
| 7 | 665 | 89 |
| 8 | 464 | 100 |
| Average female | | 97 |

## Period of Incubation

In the laboratory the period of incubation for eggs was usually five days. But in the screened insectary, where eggs got the exposure of the sun for half the day, they hatched usually in about ten days. This was in August. In the orchard where eggs will frequently be

shaded so that they will not get all of the morning or all of the afternoon sun the period of incubation may be two weeks.

It will be seen from the figures given in this paper that an average female may be expected to deposit 800 eggs, 97 per cent. of which may be expected to be fertile and 84 per cent. of which are effectively placed. This would mean that there would be an average of 650 larvæ from each female which have a chance to mature. If the infestation of an orchard remained steady from year to year it would mean that 648 of these would fail to reach maturity. In other words, only one out of every 325 would reach maturity. This would mean a mortality of 99.69 per cent., or, made on a basis of all larvæ which hatched, there would be a mortality of 99.74 per cent.

With 650 larvæ to attempt to take the place of every pair of moths which bred to maturity, it is not difficult to see why tree protectors have failed to give the desired protection against the pest. If we were to take these figures we would find that a tree protector, in order to be 50 per cent. efficient, would have to keep out 649 out of every 650 borers which are trying to find a place to enter the tree and if the protector were 90 per cent. efficient the protector would have to exclude 3,249 out of every 3,250 borers. Although 3,240 out of the 3,250 would fail to breed to maturity under normal conditions, entomologists must realize what they are trying to do when they attempt to keep out the additional nine of this tremendous number of borers which are attempting to run the gauntlet of even a 90 per cent. efficient tree protector.

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VICE-PRESIDENT G. A. DEAN: Is there any discussion?

MR. F. L. WASHBURN: It would be interesting to hear the method of taking the pictures showing the various stages of the insect.

MR. G. G. BECKER: The pictures were taken with arc light rays. Pupæ that were about ready to emerge, as indicated by a little rift which appeared across the top, were brought into the laboratory and then subjected to the rays of the arc light. Adjustments had previously been made so that on being subjected, they could be snapped at whatever stage was desired.

VICE-PRESIDENT G. A. DEAN: Mr. Hugh Glasgow will present the next paper.

## THE SINUATE PEAR BORER IN NEW YORK

By HUGH GLASGOW, *Agric. Expt. Stat., Geneva, N. Y.*

(Withdrawn for publication elsewhere)

VICE-PRESIDENT G. A. DEAN: The paper is now open for discussion.

MR. H. T. FERNALD: This paper has been interesting to me because I think it was at one of these meetings about ten years ago that the insect was first reported by Doctor Smith from New Jersey. Then it was only known in certain portions of that state. I would like to ask the speaker whether he can give us any indication of its present distribution in New Jersey which would indicate how far it has spread.

MR. HUGH GLASGOW: No, I cannot.

VICE-PRESIDENT G. A. DEAN: The next paper will be presented by Dr. E. P. Felt.

## "SIDE INJURY" AND CODLING MOTH CONTROL

By E. P. FELT, *Albany, N. Y.*

The term "side injury" or "shallow" is limited in this paper to the characteristic blemish produced by late-hatching codling moth larvæ entering the smooth side of the apple, running just under the skin a circular gallery with a radius of about one-sixteenth of an inch, and then in a few days deserting this initial point of injury and usually migrating to the blossom end. This blemish is frequently marked by a red or reddish brown discoloration and was the cause of serious loss in western New York in 1915. Then it was not difficult to find sprayed orchards with 20 per cent or more of the fruit affected in this manner. There was not so much damage of this character the past summer.

The experimental work of 1916 was a continuation of that of the preceding year and in tabulating results, pains were taken to distinguish between this "side injury" or "shallow" and other codling moth work.

We have brought together in the above tabulation, a comparison of conditions found in two Orleans County orchards—one Greening and the other King apples. It will be noticed, as in the Kendall orchard, that the yield for the plots of six trees sprayed once, twice and three times, varied in an almost uniform descending series from nearly 7,000 to approximately 1,500 apples, while in the Albion orchard, the range was from nearly 3,500 to approximately 6,400, the plot sprayed twice in the latter orchard being the one producing the smallest crop. We desire in this connection to call attention to the fact that the variation in the percentage of wormy apples appears to be affected more by the size of the crop than the number of sprayings and, moreover, that there is a fairly constant ratio between the total

TABLE I. COMPARISON OF WORMY APPLES IN KENDALL AND ALBION ORCHARDS, 1916

| Plot | Kendall Orchard (Greening) | | | Albion Orchard (King) | | |
|---|---|---|---|---|---|---|
| | Total fruit | Total wormy | Shallow | Total fruit | Total wormy | Shallow |
| 1 Total | 6,838 | 662 | 339 | 5,755 | 606 | 267 |
| Per cent | | 9.68 | 4.96 | | 10.53 | 4.62 |
| 2 Total | 3,064 | 266 | 150 | 3,477 | 384 | 245 |
| Per cent | | 8.68 | 5.87 | | 11.04 | 7.04 |
| 3 Total | 1,450 | 207 | 175 | 6,419 | 540 | 381 |
| Per cent | | 14.27 | 12.06 | | 8.41 | 5.93 |
| 1-3 Total | 11,352 | 1,135 | 664 | 15,651 | 1,530 | 893 |
| Per cent | | 10.01 | 6.11 | | 9.77 | 5.09 |
| Checks Total | 988 | 129 | 89 | 643 | 201 | 51 |
| Per cent | | 13.05 | 9.00 | | 31.25 | 7.93 |

wormy fruit and the apples showing side injury. In plot 1 for both orchards nearly one-half the wormy apples are affected in this manner, while in plots 2 and 3 and the checks for the Kendall orchard, it is practically two-thirds, with the exception of plot 3 for the Kendall orchard, where the reduction is approximately one-fourth, and this latter is equally true of the one check tree in the Albion orchard.

TABLE II. COMPARISON OF PERCENTAGES BETWEEN WORMY AND "SHALLOW" APPLES, 1916

| Plot | Kendall Orchard (Greening) | | | Albion Orchard (King) | | | Hilton Orchard (Baldwin) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Wormy | Approx. Shallow | Shallow | Wormy | Approx. Shallow | Shallow | Wormy | Approx. Shallow | Shallow |
| 1 | 9.68 | 4.84 | 4.96 | 10.53 | 5.26 | 4.62 | 17.55 | 8.77 | 7.99 |
| 2 | 8.68 | 5.78 | 5.87 | 11.04 | 7.36 | 7.04 | 16.05 | 10.70 | 9.15 |
| 3 | 14.27 | 9.41 | 12.06 | 8.41 | 5.61 | 5.93 | 12.54 | 7.36 | 8.45 |
| Ch. | 13.05 | 8.60 | 9.00 | 31.25 | 20.83 | 7.93 | 10.87 | 6.25 | 5.93 |

In order to bring this point out more clearly, we have brought together in Table II, a comparison of the percentages between the total wormy and "shallow" apples in three orchards representing three varieties, namely, Greening, King and Baldwin, sprayed by different groups of men, though under the same general supervision and undoubtedly subjected to varied treatments in earlier years. They were all within twenty miles of each other and under very similar, if

not almost identical climatic conditions. This table shows that, with a few exceptions, which latter are to be expected, it was possible to approximate the percentage of fruit showing this side blemish, by taking a definite proportion from the percentage of total wormy. This for the three plots sprayed once, was one-half and for the plots sprayed two and three times and the check trees, one-third, with the exception of the check tree in the Albion orchard. This latter, as may be seen by referring to the first tabulation, bore a small crop and a very large number of wormy apples. The percentages calculated in this manner varied from the actual by less than one and in a number of instances by only one-half of 1 per cent or considerably less. This may be only a striking coincidence. It seems to us very probable that, broadly speaking, there is a somewhat definite relation between the "shallow" infested apples and the total wormy, and this would certainly be the case if the young codling moth larvæ reacted to an hereditary instinct and excavated a temporary mine in leaf or apple, as the case might be, before working into deeper tissues. It is not even suggested that the proportions mentioned above would apply to all orchards. The probabilities are distinctly against this, since there are undoubtedly years and sections where a much larger proportion of eggs is deposited on the leaves than on the fruit; for example, one branch in an orchard near Lockport was examined by Mr. L. F. Strickland, state nursery inspector, July 24 last, and on 38 apples he found four eggs, and on the 171 leaves only one, a condition by no means unusual in western New York, judging from our own observations.

The apparent reduction of one-sixth of the total infestation, the difference between one-half and one-third of the wormy apples is not necessarily an indication that the second spraying, applied about three weeks after blooming, is efficient to that extent in eliminating side injury. The mere fact that one-third of all the wormy show the shallow type of injury on both the plots sprayed two and three times, and the check trees, with the exception noted above, would raise a question as to the real significance of this variation. It is, practically speaking, comparatively slight and we believe that the probabilities are against this variation being especially significant. It is a source of regret that no conclusive date along this line can be submitted.

A similar condition obtains if we compare the yields of the experimental plots in the Kendall orchard for 1915 and 1916. It should be stated that the plots were identical, the treatment was the same in two successive years, and the crop on each plot was practically the same as the year before. Considerable more spray was applied in 1916 and the work was very thorough. The percentage of wormy

fruit on the plots sprayed once was reduced from 27.67 to 9.68, and that for the other plots in approximately the same ratio. This was likewise true of the "side injury" or "shallow" for the two years, so far as these could be compared, owing to the fact that there was a slight change in classification in 1916. The relationship between the two types of injury was so close that a proportion showing the percentage reduction in the total wormy and giving the percentage of "shallow" for one year would work out to very nearly the percentage of "shallow" for the second year. This was true not only of plots 1 and 2, but of plot 3 and the check trees. The complete data are not given here and the above is brought to notice as additional evidence bearing upon this general problem.

Generally speaking, the development of side injury is conditioned upon the deposition of numerous eggs after the apples have become an inch or so in diameter and smooth enough so as not to repel the parent moth. We are satisfied that by far the greater benefit comes from the spraying just after blossoming and that the "side injury" is in general proportional to the infestation of the orchard. Moreover, the probability of securing immediate results in checking this type of mischief is not good and we look for a material benefit from last spring's treatment in reducing the probabilities of extensive side injury in 1917.

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VICE-PRESIDENT G. A. DEAN: Is there any discussion on this paper?

MR. E. D. BALL: I would like to ask Doctor Felt whether the statement to the effect that the "shallows" are from larvæ that later went into the calyx cups is from experimental data.

MR. E. P. FELT: It depends a little on just what you mean by experimental data. We examined in 1915 a great many apples showing that type of injury. A considerable portion of them were empty, and in a number of instances we found young larvæ later working in the calyx. In one or two cases larvæ were to be seen half way between the "shallow" type of injury and the calyx and the mere fact that you can find so much of this "shallow" type of injury with no indication of serious injury leads us to believe that this is the logical explanation.

MR. E. D. BALL: These results do not agree with our western work, but of course we did not work on any of those varieties of apples. We call these marks "blinds" in the West. We consider where we find a "blind" that it has been made by a larva which has died from some cause or other, and this view seems to be pretty well established for that region. When a young larva dies there is nothing left but the black head. Often four or five of these "deadheads" (as we call them)

have been found in a single calyx. The question whether larvæ migrate from one point to another is very interesting. Under extremely wormy conditions in the West as high as forty-two eggs have been found around each apple on an average tree. Under such conditions the finding of a larva in the calyx would not prove that it came from a "blind."

MR. E. P. FELT: Doctor Ball asked me to explain. May I ask him to explain? If these are "deadheads" in a certain sense, why is it that we should have substantially the same percentage on our check trees as on our sprayed trees,—trees that have had no poison? I cannot get over that.

MR. E. D. BALL: I saw that point at the time and cannot get over it either. This habit of the larva of coming out and exposing itself on the surface of the apple a second time is also hard to reconcile. We thought we taught it better than that.

MR. E. H. SIEGLER: In connection with the control of the codling moth, I have been asked to make a few additional remarks upon the paper entitled "A Codling Moth Trap" which appeared in the last issue of the JOURNAL OF ECONOMIC ENTOMOLOGY. I have brought along the same illustrations which are shown in the JOURNAL and also have a small model which I shall pass around for your inspection.

As you will note, the trap consists of a strip of burlap folded to three thicknesses and sufficiently long so as to encircle the trunk of the tree. The burlap is then covered with wire screen, twelve meshes to the inch, and is securely attached to the tree trunk. The principle of the trap is founded upon the fact that the codling moth larva can enter a smaller opening than through which the moth can escape. The larva enters the trap through one of the openings of the wire screen and spins its cocoon beneath the burlap. Finally, the moth upon emerging is trapped beneath the wire screen.

It is a well known fact that many codling moth larvæ may be captured beneath cloth bands attached to the trunk of the tree and this method has been employed more or less for many years. However, the labor involved in examining the bands so as to destroy the larvæ beneath has greatly limited this practice. With these facts in mind, it therefore seemed of prime importance to ascertain whether or not the codling moth trap would prove as attractive a cocooning place for the larvæ as the usual cloth band. In order to secure this data, twelve trees in a commercial orchard were selected and around the trunk of each a burlap band was placed. A strip of wire screen was then attached to the trunk so as to cover the burlap half way around the trunk. It will thus be seen, that by this arrangement,

the larvæ leaving the fruit on each tree were free to spin up either beneath the uncovered portion of the burlap or else to pass through one of the meshes of the wire screen in order to cocoon in the burlap beneath. Experiments of this nature were started upon two trees July 1, upon two additional July 14, upon four trees July 17, and upon four more August 22. Examinations were made July 5, 14, 17, 20, 28, and August 9, September 8, October 30. The total number of insects captured upon these trees was 1,582 of which over 49 per cent voluntarily entered the traps. Thus from the information at hand, it would appear that the trap will entice approximately as many codling moth larvæ as will the ordinary cloth band.

Another experiment included five trees, the trunk of each of which was completely encircled by a codling moth trap. Three of these traps were placed July 1, one July 5, and one on August 22. During the period from their placement until October 30, 601 individuals, including larvæ, pupæ and moths were captured.

The information upon the codling moth trap is by no means complete as yet, but the indications are that this device may be profitably used, especially in regions where the codling moth is abundant. The use of wire screen traps is not necessarily limited to the codling moth but may be extended so as to include other insect pests.

MR. E. D. BALL: This seems to offer a possibility of great service in the badly infested regions. There are one or two suggestions, however, that I should like to make. First, that it would be better to put two or three strips up and down on a tree rather than a single encircling one, for fear that this would be left on and kill the tree. The second is that I was much pleased with the success Mr. Siegler was having in rearing codling moth larvæ in strips of corrugated board and I am wondering if this would not be still better than burlap in these trap bands.

MR. E. H. SIEGLER: That is a good suggestion. However, there is greater likelihood of catching more larvæ if the trap completely encircles the trunk. There is, of course, no need of the trap until the trees come into bearing, at which age the wire screen is scarcely strong enough to cause girdling. As the trees grow older the possibility of girdling is still further removed.

I am inclined to prefer the burlap since it is more durable than the corrugated pasteboard. There is no occasion to remove the burlap band during the season, and it should therefore be of service for several seasons.

MR. E. D. BALL: Where burlap is left out all winter most of the lint and short fibres are washed out and when a double fold of it is held up to the face one can read a newspaper through it. Larvæ will not

hide under anything they can see through. Burlap bands should be taken off and stored or else changed every year.

VICE-PRESIDENT G. A. DEAN: The next paper will be read by Mr. George G. Becker.

## THE CONTROL OF THE ROUND-HEADED APPLE TREE BORER

By GEO. G. BECKER, *Fayetteville, Ark.*

The investigations discussed in this paper were carried out at Berryville, Arkansas, in an orchard which represented as bad an infestation of the Round-Headed Apple Tree Borer as has ever come to the writer's notice. From 50 to 75 per cent of the trees of this eight-year-old orchard had been killed by this insect, though the shallow soil may have been a contributory cause to the death of some of the trees. No trees could be found in the orchard which did not show the work of the borer.

In 1913, a few over 1,000 one- and two-year-old apples trees were set out in this orchard. Trees were set out five feet in rows and ten feet between the rows. There were 67 trees to a row, and three to four rows to a plot. Plots were set out in alternate middles, so that each would have a vacant middle on either side. White Lead Paint ,Sherwin-Williams' Pruning Compound, Screening, and Asphaltum, in varying combinations with oils, were tried out. Except for the screened trees, all were treated at Fayetteville and tied in bundles of 10 to 13 to insure that the different treatments would be well scattered out over the plots. It was thought that Asphaltum might have different effects on different varieties and, accordingly, all the tests were carried out with three varieties.

### WHITE LEAD

Previous experiments with white lead were conducted by Professor Hayhurst, and the author, in 1911, but our data were not conclusive enough. Accordingly, ninety-nine trees were incorporated in the tests at Berryville. Four per cent. of the trees were infested, this representing a protection of 56.7 per cent. Hayhurst, in 1911, found that beetles confined in a cage with twigs coated with white lead, ate through the paint. It is not unlikely that this would happen in the field. Our experiments on white lead were not continued a second year. From our tests we concluded that:

1. Trees would have to be retreated each year.
2. The protection obtained was not commensurate with the cost.

### Pruning Compound

A paint by-product, known as Sherwin-Williams' Pruning Compound, was tried in the tests. It was thought that this material might be as efficient as white lead, and at the same time would be cheaper. Ninety trees were treated, of which ten were infested, representing an infestation of 11.1 per cent, and a protection of −3.7 per cent. In other words, these trees were more heavily infested than the checks. Beetles ate through the paint and the material cracked and flaked badly, and it was not considered worthy of a second trial.

Conclusions: Sherwin-Williams' Pruning Compound offered no protection against the Borers.

### Paper Wrappers, Wooden Tree Veneers, etc.

Although these were not tested out at Berryville, it might be well to give a few notes regarding their use. In 1911, Hayhurst observed an instance of where a beetle in eating its way out of its pupal cell had eaten right through a tarred felt wrapper which was over the place where it emerged from the tree.

It has been the author's observation that various paper wrappers are inefficient, either because they rot or else because of the fact that they are torn and made useless by termites or ants.

It was further observed in the old orchard at Berryville that trees wrapped with newspapers, as a protection against rabbits, almost invariably harbored under these wrappers a colony of ants. These ants were observed attending a species of pseudococcus, and it is not unlikely that they would establish symbiotic relationship with the Woolly Aphis.

Wrappers also tend to keep the trunks of the trees cool and moist, and it was observed that the conditions thus established were especially conducive to attacks of *Synanthedon pyri*, which insect is quite common in the Ozarks. At any rate, Synanthedon seemed to thrive especially well under the paper wrappers. The same objections would perhaps be found with wooden tree veneers. Moreover, if our screening tests would be indicative, this veneer would have to be altered each year to allow for growth of the trees, which would add to the cost of their use as protectors.

Conclusions: 1. Paper wrappers and tree veneers may be dangerous on account of harboring other insect pests.

2. The retreatment and readjustment each year would perhaps make the cost out of the question.

### Screening

The use of 12-mesh screening is so costly that it would have to be very efficient and permanent to begin with, before it could be

given much consideration as a borer protector. For the screening only, the cost would range from one cent for a two-year-old tree, to about six or seven cents for a 12-year-old tree.

In these tests, screening was so applied that it would stand out all around the tree. A few strands of the wire were pulled out along one edge and the free ends were then passed through the other edge of the screening and bent over, thus securely locking the protector around the tree. The screening was then crimped around the top and securely fastened to prevent adults from entering.

At the end of the first year it was noticed that the screens were rusted out below the surface of the ground. Were it not for this, it would seem that screening would last at least three years. It was found, moreover, that the screening had to be readjusted each year. Another objection against screening was the fact that a tendency to girdle the trees readily developed when screens were tightly fastened around the top.

Examination of 133 screened trees showed that only two were infested in 1915, thus representing a control of 85.9 per cent. In the second year, 15 were infested and the control was only about 51.3 per cent. In the case of the infested trees, it seemed that beetles must have deposited through the meshes at a point where the screening happened to touch the trunk of the tree. Other cases, trees were infested when there was no means of accounting for how the beetle could have deposited its egg in the tree.

Conclusions: 1. That the cost of screening makes it prohibitive as a protector.

2. The danger from girdling is another factor against its use.

### Asphaltum

After investigation, it was thought that asphaltum might hold some promise as a borer protection, provided that it did not injure the trees and it was sufficiently permanent not to require much retouching. It was found that two pounds of asphalt were required to cover a twelve-year-old tree, and that one pound would cover about 10 two-year-old trees.

In 1912, some preliminary tests were made on twelve-year-old trees. Results indicated that where the asphalt covered the bark it caused a tendency for excessive deposits of cork to form. The trouble did not appear to be due to the heat of application, because in this case the living tissue would have been killed in places. It was thought that trouble might have been augmented at least by heat which might have been absorbed on account of the black color of the asphalt. This seemed improbable because the injury was no worse on the south,

east or west sides than on the north. From the fact that the bark appeared normal where the asphalt cracked or chipped off, it seemed most likely that the presence of asphalt impaired the process of respiration.

Preliminary tests were made with two-year-old apple trees to see what effect treatment would have. Twenty-four trees were treated at temperatures ranging from 235 to 175 degrees C. The trees were submitted to Professor Hewitt, Plant Pathologist, whose report follows: "The asphaltum tests indicated that trees would stand asphaltum as hot as 203° C. without apparent injury, provided it was quickly applied, though a tree treated from 140 to 150 degrees C. was injured, when the application was prolonged to one-half minute. It thus appears that young trees could stand a high temperature for a short time better than a somewhat lower temperature unduly prolonged."

After the preliminary tests, it was decided to try asphaltum in the tests at the three different temperatures. One at the lowest temperature at which the raw asphalt would spread efficiently (about 150° C.); another at 130° C.; and a third at 115° C. The melting points in the latter two instances were reduced with oils. In order to determine whether it would be desirable to have the oil dry out rapidly, or to have it remain in combination longer, gasoline, kerosene and linseed oil were used. Thus, asphalt was used in seven combinations.

1. Asphalt applied at about 150° C.
2. Asphalt with melting point reduced to 130° C. with gasoline.
3. Asphalt with melting point reduced to 130° C. with kerosene.
4. Asphalt with melting point reduced to 130° C. with raw linseed oil.
5. Asphalt with melting point reduced to 115° C. with gasoline.
6. Asphalt with melting point reduced to 115° C. with kerosene.
7. Asphalt with melting point reduced to 115° C. with raw linseed oil.

As before indicated, in order to see whether some varieties might be more susceptible than others, tests were carried out with three varieties which were considered as fairly representing tough, medium and tender barks. Mammoth Black, Jonathan, and Yellow Transparent were selected.

Our conclusions in regard to asphaltum were:

1. Asphaltum will not make an absolutely borer proof coat, because of its tendency to crack, due, presumably, to the pressure of growing bark in cool weather when the coat is brittle. Exceptions should be noted here in the case of linseed oil mixtures, which remain more plastic.

2. Moisture tends to make asphalt brittle, causing it to flake off.

3. Buds in growing, readily push through the asphalt coat, thereby making it defective.

4. Cracking of asphalt coat is worse with older than with the younger trees.

5. Woolly Aphis was encountered in a number of instances, established beneath the asphalt coat where the tree has apparently shrunken from it.

6. It is the opinion of Professor Hewitt that asphalt injury will, in some instances, be conducive to the entrance of crown gall.

7. Injury to trees was frequent and occurred to such an extent as to warrant discouraging its use altogether as a borer protector. The average for all asphalt treated trees was 22.9 per cent injury, though it ranged as high as 40 per cent, depending on variety of tree and treatment.

8. Injury seemed to vary directly as the heat of application. Raw asphalt caused 26.6 per cent injury. The 130° averaged 22.7 per cent injury and the 115° mixtures averaged 7.9 per cent injury.

9. Our data suggested that the kerosene asphaltum mixtures might cause a little more injury than the other oil mixtures, though this is by no means conclusive.

10. Injury varied with the variety. For all asphalt treated trees it was 15.1 per cent, 21.5 per cent and 25.2 per cent, respectively, for Mammoth Black, Jonathan, and Yellow Transparent.

11. Injury was of two types. (a) One type due, apparently, to scalding of the bark as a result of the heat of application. It was characterized by killing of the bark, usually along one side, which frequently induced a malformed, gally condition, due, presumably, to the attempted healing over of killed bark by the surrounding growing tissue. (b) A second type of injury appeared to have been induced by interference with the normal process of respiration. It was characterized by greatly enlarged lenticels, frequently accompanied by excessive deposits of cork.

12. Injury in the young trees was less the second year than the first, which indicated that it was due mostly to the heat of application.

13. Injury of the second year was confined to a corky type, due to impairing of the process of respiration.

14. The older trees appeared not to have been injured by scalding, but seemed to be injured by the impairment of the process of respiration, as indicated by immense deposits of cork.

15. As a protection against borers, asphalt gave protection of 82.1 per cent the first year for all trees.

16. The asphaltum combinations with oil apparently give a little better protection than the raw asphalt, due, presumably, to the fact that the oil mixtures were more plastic and permitted the growth of the trees without cracking the asphalt coat. Raw asphalt averaged

a protection of 69.1 per cent, but all the oil mixtures averaged 85.9 per cent.

17. Though the trees were retouched, treatment was less effective the second year than the first, the average protection the second year being 7.7 per cent as against 82.1 per cent for the first.

18. Up to a certain age, it appeared that asphalt varies in efficiency inversely as the age of the tree. In other words, the older the trees the less efficient the treatment.

As a result of our investigations at Berryville, we concluded that the most practical manner of handling the borer properly is by worming the tree at the right time every year.

SUMMARY

1. That the protection offered by white lead is not commensurate with returns.

2. That pruning compound is worthless as a borer protector.

3. That paper wrappers and wooden veneers, from first observations, appear to be impracticable.

4. That the cost of screening is too great to warrant its use as a borer protector.

5. That the use of asphaltum is attended with injury and that its efficiency as a borer protection is not worthy of the risk to the trees.

6. That worming the trees during the months of August and in early September is the most practicable as well as the cheapest method for the controlling of the borer.

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VICE-PRESIDENT G. A. DEAN: If there is no discussion, we will now listen to a paper by Mr. George H. Lamson, Jr.

## MERCURIAL OINTMENT, AN EFFECTIVE CONTROL OF HEN LICE

By G. H. LAMSON, JR., *Storrs, Conn.*,

Insecticides, such as the arsenate of lead, lime sulphur, hellebore, hydrocyanic acid gas, carbon bisulphide and nicotine solutions, are of known value and it is from these that the economic entomologist usually draws for the direct control of insects.

To most of you the problems of the control of insects affecting the products of the orchard, field, forest and garden are of most interest, though from time to time your attention is directed to those animal parasites that are of much economic importance.

Those attempting the control of lice on poultry have become impressed with the difficulty attending this operation for the reason that these small active forms increase in such numbers as to make many types of control impracticable or only partially efficient.

For a long time powders and dust baths have been recommended to those who would free their poultry from lice but it is the ineffectiveness of this method that I would like to emphasize at this time.

To determine the relative value of various means of control, one hundred and fifty well grown white leghorn pullets and male birds were used in the tests made a year ago last summer. This stock was badly infested with lice and they were placed in separate coops and runs so that they would keep under control and at the same time have sufficient exercise. Pyrethrum, the Lawry or Cornell, powder, lard, vaseline, mercurial ointment normal strength, and mercurial ointment dilutes one to two parts, one to three parts, one to five parts, one to ten parts, were tried, together with the usual check lot, each lot consisting of from ten to twelve birds.

The results from these tests were very marked, showing distinctly the inefficiency of the dusting methods even when the operation was repeated several times, for the test extended over the whole summer. The vaseline and lard were more effective over a longer period than the powders. Of the powders, the Cornell (Lawry) powder made up of two and one-half pounds of plaster of paris, one-fourth pint of crude carbolic acid and three-fourths pint of gasoline, caused the death of many lice soon after the powder was applied. As a demonstration of this, these lice were shaken on a large clean piece of paper. This result seemed a positive evidence of effectiveness, but on examining the birds so dusted a few days afterward the numbers of lice seemed to have been but slightly diminished, making continued applications necessary, yet never quite freeing the hens of the lice.

The fact that a hen dusted with a powder shakes much of that powder out of her feathers soon after the mixture has been applied, accounts for a loss of some of the effectiveness of this method. Most dusts, too, lose their effectiveness long before the next generation of lice is hatched. The dust baths are likely to become non-effective by being covered with feathers and accumulated excrements, making them damp and hard.

The use of the mercurial ointment did not cause the death of the lice so quickly, but within a few days no lice could be found upon the hens and this condition lasted over a period of from eight to sixteen weeks. The mercurial ointment caused some burns but the dilution of one part mercurial ointment to two parts vaseline controlled the lice and caused only a few slight irritations that lasted but a short

time. The more dilute mercurial preparations lost their effectiveness as the amount of mercury was diminished.

After this one hundred and four chickens were treated in the laboratory where they could be under close observation. Here tests were made with these preparations, particularly the mercurial ointments of various strength. The ointment was applied to different parts of the body such as on the head, under the wings and under the anus. The application of the mercurial ointment diluted to the strength of one part to two parts of vaseline was most effective for the largest number of birds when applied under the anus or vent. This was probably due to the fact that the two species of body lice that were more numerous upon birds studied laid their eggs in this region. The application was nearly as effective when placed under the wings and least effective when placed only on the back of the head and neck though for the hens affected with the head and body lice it would give the best results to apply to this region as well as under the anus.

The method of application was to take an amount about the size of a pea and rub it into the base of the feathers. This adheres to the finer portion of the hen's covering and remains there for a long time. A hen thus treated was kept in a glass case for a time under observation; many dead lice were found on the floor of the case while but three live lice were seen to leave her.

Some little confusion occurs in the use of the term mercurial ointment and blue ointment. Mercurial ointment contains 50 per cent of metallic mercury with 50 per cent petrolatum (vaseline).

Blue ointment is a mixture consisting of 67 per cent mercurial ointment and 33 per cent vaseline, and, therefore, contains about 33 per cent of mercury.

Mercurial ointment costs $1.75 per pound while blue ointment costs $1.50 per pound. It is, therefore, cheaper to buy the mercurial ointment and dilute it with vaseline, using one part of the former to two of the latter. To mix this it is best to place the ingredients on a pane of glass and work them together with a case knife, being sure that the mixing is thoroughly done. Place in a receptacle and label. An ounce of this ointment is sufficient to treat from sixty to seventy hens while the application can be made almost as fast as the hens can be caught. In that much time is likely to be spent in catching the fowl, it is best to do this work after the birds have gone to roost. The cost involved to buy and apply this ointment is less than one-half cent for each hen. To be sure this should not be used for the setting hens on account of the effect it might have upon the respiration of the chick embryo, but if applied one or two months before, the hens will not be

lousy at the incubating period. For the young chickens a little sweet oil is a practical control measure owing to the tenderness of the skin.

Mercurial ointment is by no means a new insecticide as it has been used for years in the control of Pediculidæ. It has been used also in Denmark and other European countries on cows for cattle lice. Its value as an insecticide for hen lice has as yet not been widely known, yet those who have given this a trial have become enthusiastic over the results obtained and consider it a specific.

It seems hardly possible that a small amount of mercurial ointment applied to a restricted region of a hen's body will free it from lice but the results are above expectation.

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VICE-PRESIDENT G. A. DEAN: The paper is now open for discussion.

MR. D. M. ROGERS: May I ask how frequently the lice must be treated?

MR. G. H. LAMSON, JR.: We determined that the application in the summer would last two or three months. When applied in the fall or winter, it would last four or five months, so I believe in the North that three applications would keep hens free from lice throughout the year. Probably in the South it would take four or five more.

MR. Z. P. METCALF: In North Carolina, six applications a year are necessary to keep the hen louse in control. The head louse seems to require more than six applications a year as it is not as easily controlled as the hen louse.

VICE-PRESIDENT G. A. DEAN: We will now pass to the next paper by Mr. Z. P. Metcalf.

## LIME AS AN INSECTICIDE[1]

Z. P. METCALF

In 1912 Mr. C. B. Williams, chief of the Division of Agronomy of our station called my attention to the ravages of the common and four-spotted cow-pea weevils (*Bruchus chinensis* Linn. and *B. quadrimaculatus* Fabr.) in the cow peas that were being saved for seed by the station. I at once suggested to him that we fumigate them with carbon bisulphide, which was done, using four pounds to 1,000 cubit feet of air space in a very tight bin at 74° F. for 72 hours. Contrary to our expectations, however, the cow pea weevils continued to breed in undiminished numbers, although a great many adults were killed at the time the fumigating was done

[1] Contributions from the Department of Zoölogy and Entomology of the North Carolina College of Agriculture and Experiment Station, No. 7.

I think that this was due to the fact that all stages of these weevils are to be found in the peas at one and the same time, and while this strength of carbon bisulphide is ample to kill the adults that have emerged from the cow peas it does not have any effect on the stages in the pea nor on the eggs which are glued to the outside of the pea. Hence the following year we went a little farther afield and tried, not only the carbon bisulphide at fifteen and thirty pounds per 1,000 cubic feet of air space, but also tried mixing peas with kerosene at the rate of one-half and one pint per bushel, crude carbolic acid at the same strengths, and air slaked lime at the rate of one part to four parts of peas and at the rate of one part to eight parts of peas. These peas were treated late in September, 1913, and left until the following spring when it was found upon examination that the peas treated with air slaked lime one to four gave a germination of 71 per cent, the peas treated with air slaked lime one to eight a germination of 48 per cent; whereas, the peas treated with carbolic acid gave only 21 per cent, those with kerosene 21.5 per cent, and those with carbon bisulphide 17.5 per cent. This led us to believe that air slaked lime was perhaps the most effective remedy that we could use against the cow-pea weevils.

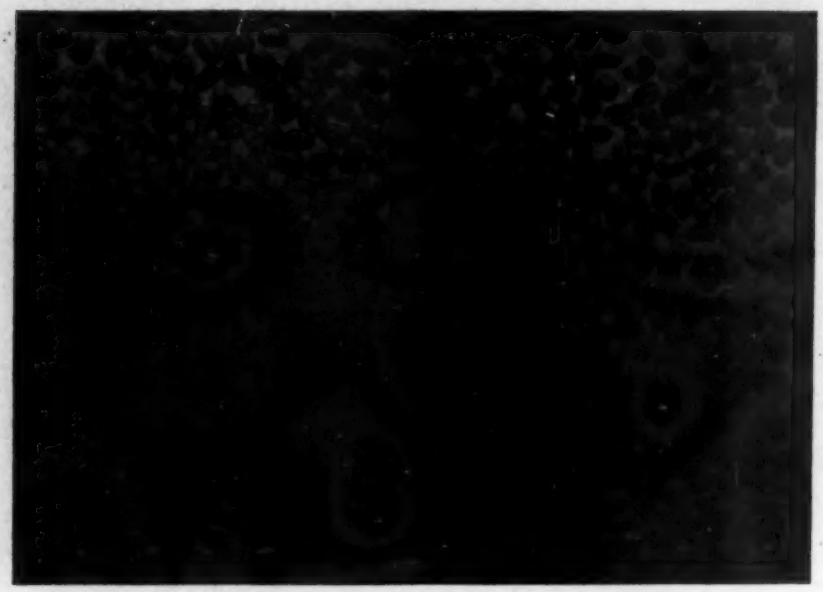
In December, 1915, we planned a somewhat more elaborate experiment in which peas were treated with varying proportions of air slaked lime ranging from four parts lime to one part peas to one part lime to eleven parts peas. These peas were moderately infested at the time they were treated, the variety called general crop in the table being the worst in this respect. Unfortunately, no germination tests were made at that time; neither were there any tests made at the usual planting time,—two critical points that were overlooked. However, treated peas were stored in ordinary sacks in the seed room and tied to each sack was a liberal sample of untreated peas which served as a check. These peas were examined this past fall, and two checks were taken upon the effectiveness of the various strengths of lime tried.

One check consisted of counting 1,000 each of the treated and check peas and then counting the number of adult emergence holes per pea. The number of adults emerging from a single pea ranged from none to twelve with a mean of 1.04 for the treated peas and a mean of 3.4 for the untreated. However, the mean of the four greatest strengths tried was .027 for the treated peas and 3.52 for the untreated peas. This is, perhaps, not altogether a fair test of the effectiveness of a remedy, for it is rather hard to believe that the lime could have any effect on the adults ready to emerge. On the other hand, larvæ that are able to pupate and then die have caused as much damage to the peas as have larvæ which pass through their transformations and

emerge as adults. So that it is possible for a pea to be completely riddled by the larvæ, yet none of them be able to get sufficient food to be able to complete their transformations; whereas, another pea may show some emergence holes and still be able to germinate a good strong plant. But in the long run I do not believe that this will hold and, with the large numbers counted, I believe that the number of emergence holes is indicative of the effectiveness of the remedy, although the exceptions noted above will have to be borne in mind. I believe that the exceptions noted in the table may be accounted for in this way. Take, for instance, the variety clay which was treated with lime one to eight parts of peas. It will be noted that more adults emerged from the treated peas than from the untreated and yet the treated peas germinated 22.5 per cent, whereas, the check germinated only 6 per cent. Now this may be accounted for in this way, adults in large numbers were ready, or almost ready, to emerge when the treatment was given. However, the amount of lime used was sufficient to prevent their laying eggs or prevented the larvæ developing in normal numbers if the eggs did hatch. On the other hand, in the untreated lot the adults emerged and laid eggs in large numbers, these eggs hatched, but the larvæ were so crowded that they failed to complete their transformations, but they did not fail to so completely riddle the peas that only a very small percentage were able to germinate.

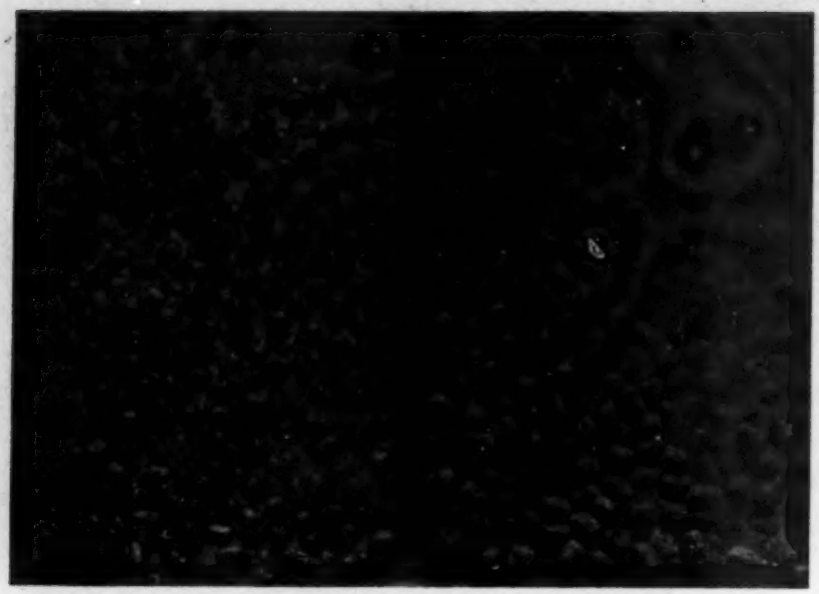
The other check on our results was the percentage germinating. These tests were made by the state botanist, Mr. J. L. Burgess, in the usual way for making such tests, and are the averages of two tests of 100 peas each. These peas were taken at random from the 1,000 peas that had been previously counted, and represent, it is believed, a fair sample of the various lots of peas. It will be noted from the table that, without exception, the treated peas gave a higher percentage of germination than the untreated peas, although in some cases the differences were not very marked, especially in the case of peas treated one to eleven. This test was in one way not fair, in that it was made several months after the usual time for planting peas, and the percentages are undoubtedly much lower than they would have been had the tests been made at planting time. But, on the other hand, if the figures are compared treated with check in each case it does give a comparison that is striking. It will also be noted that, relatively speaking, the greater the amount of lime the higher the germination and also the peas treated with lime two to one, one to one and one to two show nearly the same percentage, whereas, when we go below one to four the germination falls off very decidedly.

In conclusion, it seems safe to recommend to farmers to treat their

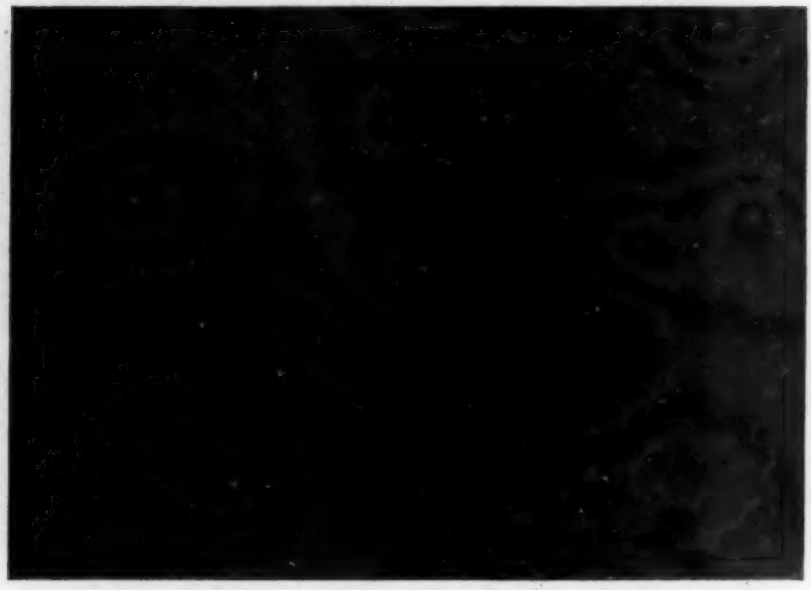


Cow peas treated with 4 parts of lime to 1 part of peas.

Cow peas treated with 1 part of lime to 2 parts of peas.
Treated on the right, untreated on the left, in both illustrations.



Cow peas treated with 1 part of lime to 4 parts of peas.



Cow peas treated with 1 part of lime to 11 parts of peas.
Treated peas on the right, untreated on the left, in both figures.

LIME AS AN INSECTICIDE

| Variety | Parts | | Number of Peas in 1,000 Showing | | | | | | | | | | | | | Total Number of Adults Emerging from 1,000 Peas | Estimated Number Adults Emerging per Bushel | Percentage Peas Germinating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | | | |
| | Lime | Peas | Emergence Holes | | | | | | | | | | | | | | | |
| Catjang | 4 | 1 | 903 | 7 | | | | | | | | | | | | 7 | 1,792 | 71.0 |
| Catjang | .. | .. | 16 | 64 | 158 | 255 | 217 | 171 | 79 | 35 | 4 | | | | | 3,619 | 857,703 | 0.0 |
| Red Ripper | 2 | 1 | 969 | 28 | 2 | 1 | | | | | | | | | | 35 | 5,180 | 53.0 |
| Red Ripper | .. | .. | | 6 | 17 | 119 | 107 | 206 | 172 | 213 | 91 | 49 | 14 | 4 | 2 | 5,755 | 817,210 | 0.0 |
| New Era | 1 | 1 | 977 | 22 | 1 | | | | | | | | | | | 24 | 4,656 | 45.5 |
| New Era | .. | .. | 12 | 137 | 321 | 369 | 102 | 48 | 10 | 1 | | | | | | 2,601 | 496,190 | .5 |
| Whippoorwill | 1 | 2 | 960 | 39 | 1 | | | | | | | | | | | 41 | 4,838 | 53.5 |
| Whippoorwill | .. | .. | 104 | 186 | 356 | 349 | 65 | 20 | 7 | 3 | 1 | | | | | 2,121 | 254,520 | 1.5 |
| General Crop | 1 | 4 | 457 | 322 | 134 | 56 | 23 | 8 | 1 | | | | | | | 892 | 196,240 | 19.5 |
| General Crop | .. | .. | 21 | 93 | 170 | 217 | 165 | 164 | 83 | 50 | 22 | 11 | 3 | 0 | 1 | 3,120 | 745,800 | 3.0 |
| Brabham | 1 | 4 | 633 | 124 | 133 | 64 | 33 | 19 | 3 | 1 | | | | | | 834 | 116,760 | 28.0 |
| Brabham | .. | .. | 3 | 60 | 206 | 338 | 234 | 114 | 22 | 7 | 2 | | | | | 2,198 | 291,018 | 0.0 |
| Two Crop Clay | 1 | 5 | 800 | 96 | 58 | 32 | 10 | 2 | | | | | | | | 260 | 52,300 | 28.0 |
| Two Crop Clay | .. | .. | 3 | 38 | 134 | 240 | 188 | 240 | 98 | 44 | 14 | 1 | | | | 4,195 | 908,275 | 0.0 |
| Taylor | 1 | 6 | 184 | 136 | 173 | 201 | 103 | 110 | 46 | 31 | 7 | 6 | 2 | 1 | | 2,681 | 313,037 | 20.5 |
| Taylor | .. | .. | 7 | 103 | 160 | 262 | 135 | 160 | 77 | 60 | 20 | 8 | 5 | 3 | | 3,546 | 365,560 | .5 |
| Black | 1 | 7 | 343 | 333 | 163 | 85 | 33 | 34 | 7 | 1 | 1 | | | | | 1,273 | 143,576 | 18.5 |
| Black | .. | .. | 5 | 31 | 147 | 263 | 197 | 189 | 95 | 62 | 7 | 4 | | | | 3,943 | 534,419 | 0.0 |
| Clay | 1 | 8 | 57 | 80 | 196 | 286 | 132 | 126 | 96 | 37 | 8 | 2 | | | | 3,245 | 531,530 | 22.5 |
| Clay | .. | .. | 24 | 76 | 317 | 137 | 121 | 42 | 26 | 9 | 1 | | | | | 3,237 | 504,972 | 0.0 |
| Groit | 1 | 9 | 570 | 249 | 125 | 40 | 11 | 5 | | | | | | | | 688 | 98,760 | 21.0 |
| Groit | .. | .. | 230 | 300 | 323 | 112 | 31 | 4 | | | | | | | | 1,416 | 201,072 | 7.5 |
| Wonderful | 1 | 10 | 147 | 161 | 284 | 227 | 79 | 74 | 18 | 8 | 1 | 1 | | | | 2,277 | 288,400 | 20.5 |
| Wonderful | .. | .. | 3 | 44 | 102 | 183 | 173 | 123 | 108 | 132 | 39 | 22 | 9 | 3 | | 4,604 | 543,272 | 0.5 |
| Black Unknown | 1 | 11 | 464 | 212 | 134 | 110 | 45 | 27 | 5 | 3 | | | | | | 1,176 | 164,640 | 6.5 |
| Black Unknown | .. | .. | 77 | 220 | 368 | 225 | 90 | 52 | 28 | 23 | 11 | 4 | 2 | | | 2,534 | 315,500 | 3.5 |

peas by storing them in air slaked lime at the rate of one part lime to two parts peas by weight; at least, until something more effective and something cheaper and simpler can be devised for the average farmer.

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VICE-PRESIDENT G. A. DEAN: Is there any discussion?

MR. G. W. HERRICK: Just how were the peas treated? Was the lime put on and simply shoveled over and over?

MR. Z. P. METCALF: We simply took air slaked lime and poured over the peas and then we put them back into the sacks, no attempt being made to mix the lime thoroughly with the peas.

MR. G. W. HERRICK: Did you moisten the peas?

MR. Z. P. METCALF: No.

MR. R. A. COOLEY: How soon after harvesting were the peas treated?

MR. Z. P. METCALF: In this case they were treated in December. Better results would have been secured if they had been treated in September directly after harvesting.

MR. W. E. HINDS: I am very much interested in this matter because it is of great importance, especially to the Gulf States. One point in connection with the treatment by carbon disulphide that interested me particularly was the serious injury to germination that resulted. I have heard from other sources of serious injury to peas from carbon disulphide treatment and would like to mention one series of experiments made at Auburn, Alabama, last year. Several varieties of cow peas were submerged in liquid carbon disulphide for periods ranging from approximately a minute to a thousand hours with absolutely perfect germination in all cases. The tests that we have made show that these differences are due to the varying percentage of moisture in the seeds at the time of treatment. Dry seeds were uninjured.

MR. Z. P. METCALF: I did not intend to state that peas treated were injured by the carbon disulphide. They were injured by the weevils. The weevils kept right on laying eggs after we treated them. We had to make continuous applications. I do not think that there was any injury by carbon disulphide.

VICE-PRESIDENT G. A. DEAN: The next paper on the program will be read by Mr. W. C. O'Kane.

## SOME FACTS ABOUT CARBON DISULPHIDE

By W. C. O'KANE, *Durham, N. H.*

(Withdrawn for publication elsewhere.)

VICE-PRESIDENT G. A. DEAN: Is there any discussion of this paper?

MR. H. T. FERNALD: Professor O'Kane has dwelt on the side of the question dealing with the efficiency of the treatment against the insects. Has he any observations to give us as to whether this treatment had any effect on the plants involved?

MR. W. C. O'KANE: We have a lot of information, but I do not have the data with me.

MR. H. T. FERNALD: Several years ago we made tests of the carbon disulphide method of controlling onion maggot by placing the material in the soil near the young onion plants. We found it possible to kill the maggots, in many cases. Taking our results in a general way they corroborate those of Professor O'Kane as to killing them all, but many of the treated plants were injured.

VICE-PRESIDENT G. A. DEAN: Mr. E. R. Sasscer will present the next paper on the program.

## RECENT VACUUM FUMIGATION RESULTS

By E. R. SASSCER, *Bureau of Entomology, Washington, D. C.*

(Withdrawn for publication elsewhere)

VICE-PRESIDENT G. A. DEAN: Are there any remarks?

MR. R. A. COOLEY: I would like to ask what provision has been made for exhausting the gas from the large cylinders.

MR. E. R. SASSCER: The exhaust gas is passed through a solution of sodium hydroxide. One firm passes it through a reclaiming hydroxide and uses it twice. Another simply allows it to pass through and lets it escape into the air through the roof.

VICE-PRESIDENT G. A. DEAN: We will now listen to a paper by Mr. P. J. Parrott.

## THE RADISH MAGGOT AND SCREENING

By P. J. PARROTT, *Geneva, N. Y.*

In western New York root maggots are very destructive to radishes, and in clay soils, especially, this vegetable can no longer be grown with any assurance that the plants will be free from injury. As screening of beds has proven satisfactory for the production of seedlings of late cabbage, experiments have been carried on by the New York Agricultural Experiment Station for the past three years to ascertain the effects of growing radishes under cheesecloth on the quality and growth of the roots.

In brief, the methods of conducting the tests are as follows:—Commencing with the latter part of March the radish seed is sown by means of a garden drill in beds at intervals of one week until about the middle of May. As soon as planting is completed, the frames, consisting of 12-inch boards, are placed in position when the cheesecloth is attached. With the appearance of the first pair of true leaves the plants were thinned and weeded; and when of desirable size they were pulled and weighed.

The weights of plants grown in screened frames and in open beds for the years 1914–16 are given in Table I.

TABLE I, SHOWING WEIGHTS OF RADISHES IN SCREENED AND OPEN BEDS

(Counts and weighings are based on rows of 100 feet in length.)

| | Screened | | | Not screened | |
|---|---|---|---|---|---|
| Year | No. of Plat | No. of Plants | Weight | No. of Plants | Weight |
| 1914 | 1 | 506 | 9 lbs. 9 ozs. | 496 | 4 lbs. 0 ozs. |
| | 2 | 332 | 6 " 14 " | 240 | 1 " 14 " |
| | 3 | 324 | 6 " 4 " | 345 | 2 " 8 " |
| | 4 | 347 | 9 " 3 " | 230 | 2 " 9 " |
| | 5 | 518 | 8 " 6 " | 532 | 5 " 9 " |
| | 6 | 518 | 9 " 12 " | 478 | 5 " 1 " |
| 1915 | 1 | 710 | 11 " 6 " | 323 | 2 " 11 " |
| | 2 | 1092 | 12 " 4 " | 432 | 2 " 12 " |
| | 3 | 1000 | 16 " 12 " | 680 | 7 " 4 " |
| | 4 | 1004 | 12 " 4 " | 665 | 7 " 4 " |
| | 5 | 1007 | 9 " 12 " | 520 | 2 " 8 " |
| 1916 | 1 | 768 | 10 " 0 " | 725 | 5 " 3 " |
| | 2 | 852 | 9 " 9 " | 896 | 6 " 1 " |
| | 3 | 917 | 10 " 12 " | 885 | 3 " 8 " |
| | 4 | 852 | 7 " 5 " | 685 | 1 " 13 " |
| | 5 | 493 | 6 " 11 " | 420 | 3 " 1 " |
| | 6 | 896 | 9 " 4 " | 423 | 3 " 4 " |
| | 7 | 748 | 9 " 5 " | 447 | 3 " 5 " |
| | 8 | 812 | 9 " 8 " | 416 | 3 " 5 " |
| Average per 100 feet for 1914. | | 434.16 | 8.3 lbs. | 370.16 | 3.50 lbs. |
| Average per 100 feet for 1915. | | 962.6 | 12.47 " | 524 | 4.48 " |
| Average per 100 feet for 1916. | | 742.25 | 9.04 " | 612.12 | 3.68 " |

An examination of the foregoing table shows that in most of the plats in the screened frames there was a larger stand of plants as compared with the uncovered beds, and data at hand also indicated that there was a correspondingly larger number of marketable roots. As demonstrated in our experiments with cabbage seedlings, these differences are due to several factors. First of all cheesecloth, if properly attached, affords complete protection from root maggots and, according to the fineness of the mesh, reduces to a more or less extent in-

juries by the flea-beetle. Both pests, when abundant, may destroy seedlings as well as retard growth. Moreover, there exist in the screened frames superior conditions for the growth of the plants. A larger percentage of the radishes establish themselves since there is less evaporation of moisture and no baking of the soil to check their development. Incrustation of clay soil, accompanied with hot weather and slight precipitation, affords conditions that are exceedingly uncongenial to the radish and as fatal as the insect enemies to the production of roots that are mild, succulent and tender.

Adjournment.

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*Morning Session, Friday, December 29, 1916, 9.45 a. m.*

VICE-PRESIDENT G. A. DEAN: The first paper on the program will be read by Mr. Marcovitch.

## THE STRAWBERRY WEEVIL IN MINNESOTA

By SIMON MARCOVITCH, *St. Paul, Minn.*

(Withdrawn for publication elsewhere.)

VICE-PRESIDENT G. A. DEAN: As Doctor Hewitt has now arrived, we will next listen to the annual address of the President.

## INSECT BEHAVIOUR AS A FACTOR IN APPLIED ENTOMOLOGY

By C. GORDON HEWITT, D.Sc., F.R.S.C.,
*Dominion Entomologist, Ottawa, Canada*

In determining the choice of a subject for my address I have been guided by a feeling that, owing to the extraordinary progress that has been made in the knowledge and methods of applied entomology during recent years, the time at my disposal could not be occupied to better advantage than by an examination of what I believe to be fundamental to an adequate appreciation of the problems with which we have to deal and their successful solution.

We have accumulated an enormous mass of facts relating to insect life in all its manifold relations to the welfare of man, and many of these facts have furnished us with the means of determining methods of preventing or controlling the noxious effects of insect activity. But it would appear to me that we have reached a stage where our accumulated knowledge is rather like a city that has developed along the

paths marked out by ancient trails and where a need has arisen for the earnest consideration of a town-planning system. Our further progress must be based upon principles that modern experience has indicated as being fundamental to a rightly conceived and an orderly development of future investigation.

Insect behaviour constitutes the basis of applied entomology and, while that fact may now be more generally realized, I feel that if the point of view such a conception implies were constantly borne in mind we should be able to approach the solution of our problems in a manner that would lead to even greater success than has already crowned our efforts.

Action is the result of the manner in which man experiences. So, also, the reaction of an insect to its environment finds expression in the behaviour of the insect. Behaviour, as Jennings has stated, "is merely a collective name for the most obvious and most easily studied of the processes of the organism, and it is clear that these processes are closely connected with, and are indeed outgrowths from, the more recondite internal processes." Stated briefly in another way, behaviour consists in the adaptation of the insect to its environment. Anything injurious to the insect causes changes in its behaviour and conversely anything advantageous to it produces a change in the behaviour. Of the factors which regulate behaviour in insects, as in other organisms, internal conditions and processes are effective no less than external, and both may be, and generally are, the product of environment. Further, to be effective the external stimulus of the environment, whether it be physical or biological, must produce a change in the physiological state of the organism.

The activities of injurious insects which furnish the problems of applied entomology are more pronounced in countries where, for various reasons, the stability of the physical and biological environment is changed. This affords the reply to a question often asked, namely, why entomologists are faced with more problems in newer countries, such as our own, than in older countries? One of the chief causes affecting the stability of the environment and consequently the activities of the insects in such countries as the United States and Canada is the extension and development of agriculture and of agricultural areas. In countries of an older civilization the environmental conditions, particularly the agricultural conditions, are fairly stable by reason of the long period of their gradual development. In such countries we find a conservative type of husbandry with which careful rotations of crops and a fairly intensive system of cultivation are associated. In the newer countries, not only has widespread development within comparatively brief periods of time been responsible for

extensive changes in environmental conditions, but such development, particularly in agriculture, has necessitated, among other things, the importation of large quantities of the natural products, including vegetation, from older countries with the inevitable introduction of the insects affecting those products, thereby not only modifying the environmental conditions for the native insects in the new country, but also introducing into a new environment insects from another country and from a native environment more conducive to stability in behaviour. Thus the conditions are altered for both the insects native to the new country and the insects fortuitously introduced.

Formerly, the investigations of the entomologists did not extend very far beyond a study of the life-histories of insects, and control measures were largely based on such knowledge supplemented by a limited study of the insects' habits; the idea being, as we were told, "to find the weak spot in the insect's life-history." The limitations of such methods of solving entomological problems were demonstrated by an inability either to account for the outbreaks of certain insects or to discover effective means of control. Not until the behaviour of insects, that is, their reactions to their environment, to each other and to the different biological constituents of that environment, was studied with true appreciation was it possible to make satisfactory progress in the control of certain serious pests. The corn root-aphis (*Aphis maidi-radicis*) furnishes a good example of this fact. It was not until Forbes and his assistants worked out the relation of this insect to the ant *Lasius niger americanus*, on which it depends for its well-being, that any success in controlling this serious corn pest could be attained; and such control measures as the breaking up of the ant colonies in the spring and the destruction of weeds on which the ants plant their wingless aphid captives before the growth of the corn, are based solely on a knowledge of behaviour.

The reaction of an organism to environmental influences is known as a tropic reaction or a *tropism*. The external stimulus may induce a physiological state that exhibits response in movement, or the physiological condition of the organism may be changed in a more fundamental manner with the result that not only is the organism itself affected permanently, but the progeny experience the effects of the stimulus and react by a change in behaviour or even in structure. For the sake of convenience we may term such tropic reactions as *individual* and *racial*, respectively.

It will not be possible in the time at my disposal to deal with more than the main types of tropic reactions to physical factors and a treatment of these must of necessity be brief in character. Let us, therefore, consider the chief tropisms: Chemotropism, thermotropism,

hydrotropism, phototropism, and anemotropism. If time permitted, a consideration of that extensive realm of insect behaviour included within the category of instinctive behaviour would be desirable, but we must content ourselves with the knowledge that this type of behaviour is the result of reflex responses to the various types of tropisms.

Chemotropism is the reaction to stimuli of a chemical nature perceived through the olfactory sense. Inasmuch as odour is undoubtedly the most important factor in the environment of insects the significance of this tropism is evident. The chief objects of animal or plant life, are feeding and reproduction, and in the search for food or for the sexes, or in oviposition, chemotropism plays a predominant part. The sexual chemotropism of insects, particularly among the Lepidoptera, has long been a familiar phenomenon to entomologists. But it is in their response to chemical stimuli as affecting the search for food and oviposition that we find a tropic reaction that has untold possibilities in its practical application.

The vital functions of search for food and oviposition are closely associated. The female insect deposits its eggs on substances best suited for the nourishment of the larvæ. The females of *Pieris rapæ* and *P. brassicæ* select the leaves of cruciferous plants, attracted thereto by the mustard oils, a group of glucosides present in these plants, as shown by the experiments of Verschaffelt. The same investigator showed that the larvæ of the sawfly *Priophorus padi* (L.) Thomas, which feeds on the foliage of certain rosaceous plants, are probably attracted by a glucoside, amygdaline. The chemotropic reactions on the part of carrion beetles, and to excrement on the part of coprophagus Coleoptera and Diptera, are well known. Howlett induced *Sarcophaga* to oviposit in a bottle containing scatol, a decomposition product of albuminous substances; and he stimulated the oviposition response in *Stomoxys calcitrans* by means of valerianic acid. Richardson's recent work on the oviposition response of the house-fly, in which flies were induced to oviposit in response, apparently, to an attraction of ammonia in conjunction with butyric and valerianic acids, opens up suggestive lines of investigation. Barrows finds that the positive reaction of *Drosophila* to fermenting fruit is due in a large measure to amyl, especially ethyl alcohol, acetic and lactic acid and acetic ether.

While the aforementioned cases, which might be multiplied, illustrate the chemotropic responses of insects in so far as they affect the oviposition response, that is, the search for food as affecting the future larvæ on the part of the ovipositing female, there is the large class of chemotropic reactions which affect only the adult without reference to the progeny. An illustration of this class is afforded by the investi-

gations of Howlett on the fruit-flies of the genus *Dacus* in which the males are attracted by the eugonol oils, iso- and methyl-eugonol, which are constituents of oil of citronella.

The control of outbreaks of the larvæ of Arctiid moths in India by the capture of the adult moths in bait traps of the Andres-Maire pattern is an example of the manner in which practical advantage may be taken on a large scale of a chemotropic response.

The negative chemotropic reaction of insects is illustrated in the practical use of repellent odors. *Musca domestica* is repelled by certain coal-tar products such as phenol; the protection of cattle from biting flies and of man from mosquitoes is secured by the use of repellent mixtures.

Turning now to a problem of great biological interest and practical importance, namely, the different behaviour of the same species of insect to different plants, we find that what would appear to be fundamentally a chemotropic reaction is sometimes responsible for the creation of a biologically different race of the same species. In his investigations on blueberry insects in Maine, Wood has found a form of *Rhagoletis pomonella* infesting blueberries (*Vaccinium*) and huckleberries (*Gaylusaccia baccata*) that is below normal size, and this form appears to be long-established as efforts to get the apple-bred race to oviposit on blueberry and *vice versa*, failed. The physiological influence of the host plant upon the insect feeding upon it and the creation of biologically different races which may differ sufficiently to be separated as species by the tendency of members of a single polyphagous species of insect to become adapted to a particular food plant is strongly suggested by Cameron's study of the leaf-miner *Pegomyja hyoscyami* Panz. which feeds on belladonna (*Atropa belladonna*). Within this category we should also include, I believe, the case of the Arizona wild cotton weevil (*Anthonomus grandis thurberiæ* Pierce). The production of morphological changes by a change in food plants has been observed in like manner in the case of Aphides. These chemotropic responses, for that is essentially their nature, have as important a relation to the work of the taxonomist as to that of the applied entomologist.

A subject which promises results of great practical value is the study of the resistance of plants to insect attack with a view to the production of insect-resisting varieties in crops subject to injury. Comparatively little attention has been paid to this further example of chemotropic reaction, but the development of strains or varieties completely or even partially resistant to the attacks of particular insects attacking them, would place a valuable preventive measure in our hands. This is a field for joint investigation by the entomologist and the plant-breeder.

The realization that in the ultimate control of the gipsy moth in North America, the silvicultural aspect of the problem must receive serious consideration is an indication of the importance of chemotropism in the control of this pest. The elimination of favored food plants and the substitution of unfavored species such as pine are measures largely based on the principle of food attraction, that is, of chemotropism, and should be so regarded.

Enticing and suggestive as the subject of chemotropism has been shown to be, we must pass on to the next tropic reaction, namely, thermotropism. In temperature we encounter an environmental influence which is as far-reaching as it is universal in its relation to insect behaviour, and while it is inseparably associated with other factors, especially that of moisture which we shall consider later, it is in itself sufficiently potent to determine the range of insect activity in both time and space. The relation of temperature to the distribution of insects is too well known to require demonstration by examples. Merriam's laws of temperature control, namely: (1) that "animals and plants are restricted in northward distribution by the total quantity of heat during the season of growth and reproduction," and (2) that "animals and plants are restricted in southward distribution by the mean temperature of a brief period during the hottest part of the year," in general, hold true in regard to insect distribution. The importance of determining the optimum temperatures for the reproduction and development of different insects has been realized by a number of investigators, although their conclusions have sometimes been defective through neglect to take into consideration the coöperative effect of other environmental factors such as humidity. The influence of temperature on development is illustrated very strikingly in the Aphides. For example, Ewing has recently found that a constant temperature of 90° F. is sufficient to prevent completely the development of *Aphis avenæ* and that the optimum temperature for the production of wingless agamic forms of this species is about 65° F., these forms only being produced at a mean average daily temperature of about 65° F.

Practical use is now made of our knowledge of the temperature relations of insects in the employment of high temperatures as a means of insect control, and "superheating" offers great possibilities.

An interesting case of the use of temperature as a means of control is afforded by the employment of the method of close-packing of horse-manure for the purpose of preventing the breeding of *Musca domestica*. About ten years ago I found that a temperature of about 105° F. was fatal to the larvæ of *M. domestica* and in an account given before this Association in 1913 of further studies of the effects of the temperature

of the manure pile on the larvæ I showed that the larval habitat in the well packed pile was peripheral, and that excessive internal heat became practically a larvicide. Recently, Copeman has shown that practical use can be made of this principle and that close-packing of the manure is all that is necessary to prevent the breeding of flies. In a recent letter to me Copeman states that this method of control is being taken up by the military authorities on an extensive scale both in England and abroad.

Just as high temperatures are effective in insect control so also low temperatures have a like value, as is now well known. And the utilization of low temperatures in applied entomology offers a fruitful field for further investigation. Further, in northern countries exact knowledge concerning the relation of low winter temperatures, associated as a rule with degrees of humidity, to the distribution of insects is highly desirable.

The activities of all insects are so closely related to temperature that no study of their behaviour can be made without full consideration of its effects.

Closely linked with thermotropic reactions are the effects of hydrotropism, and particularly humidity. This is especially the case in the effects of climate on insect distribution and migration. The theory advanced by Ellsworth Huntingdon in his "Civilization and Climate," that as climates change nations either change with them or migrate when the change is unfavorable to more suitable climatic environment, is equally applicable to insect life. We must ever take into account the effect of the climatic stimulus on insect behaviour.

In a recent suggestive paper Pierce has called attention to the fact that "a careful study of the records of any species, charting for the time required for each activity and the temperature and then similarly for the humidity, will disclose temperature and humidity points of maximum efficiency. With the boll weevil these points lie approximately near 83 degrees F. and 65 per cent of relative humidity." This author has also pointed out the practical applications of a knowledge of the relation of climatic conditions to the control not only of the cotton boll weevil, but also to such pests as the cattle tick and the fall army-worm. Other cases are numerous.

We have always to bear in mind that a tropism may include reactions to a stimulus existing in very diverse forms. This fact is well demonstrated in the case of hydrotropism. The negative hydrotropism of the salt-marsh mosquitoes of New Jersey and San Francisco is a reaction to water *en masse*, as is the positive hydrotropism of aquatic Coleoptera and Hemiptera. On the other hand, the reaction of insects to humidity is a hydrotropism that may be brought about

by diffused moisture in the air. Similarly, moisture in the soil affects the behaviour of insects considerably, as Wheeler has shown in the case of many species of ants, and as Parker has demonstrated in his study of the sugar-beet root-louse (*Pemphigus betæ* Doane) in which it was found that soil moisture is a very important factor in controlling the rate of increase in colonies of this insect. The attraction of the so-called "watershoots" of trees such as apple for aphides should be regarded as being in effect a hydrotropism.

The importance of moisture as a factor in insect behaviour is strikingly illustrated in the case of some of our most important grain insects. Forbes has discussed the effect of drought and rainfall upon the abundance and suppression of the chinch bug in Illinois. In Canada we find that the prevalence of the western wheat-stem sawfly is governed by humidity. A lack of precipitation causes a dearth of flowering stems among the grasses in which this insect normally breeds, resulting in a decrease, the abundance of the insect depending primarily upon the prevalence of suitable grass stems. Similarly, a lack of moisture is an important natural check on the Hessian Fly, a dry season being generally recognized as prejudicial to the fly. In Manitoba, Criddle finds that the partial second brood is frequently destroyed completely by the premature ripening of the grain due to the hot weather conditions in late July. Further instances might be given of the effect of moisture on other classes of insects but sufficient has been said to indicate the diversity of the hydrotropic type of behaviour.

Reaction to light plays a prominent part in insect behaviour and numerous are the examples that might be given, were it necessary, of phototropism in insects. But while entomologists are familiar with the manner in which adult insects such as Lepidoptera are attracted to light and with the negative phototropism of many larval forms, and of adult insects such as *Anopheles*, we are still far from anything approaching a working knowledge of this reaction. Such knowledge will undoubtedly place a valuable weapon in the hand of the applied entomologist. In some cases we are able already to take advantage of this type of behaviour. Swaine finds that the destruction of piled logs by the wood-boring larvæ of the sun-loving *Monohammus* can be prevented by forming a dense shade over the logs by means of brush. In his study of the army cutworm (*Euxoa auxiliaris*) in Alberta, Strickland found that the larvæ are negatively phototropic and hide beneath the soil till about four or five o'clock in the afternoon when they come to the surface and feed. With the weaker light they become positively phototropic and a general migration in a westerly direction takes place. When food is scarce hunger may overcome their aversion to sunshine with the result that the larvæ come above ground, but they still display

a modified negative phototropism and migrate in a northwesterly direction. These facts are of practical value in controlling outbreaks of this insect.

The two previous tropisms, operating together, constitute perhaps the most widely operative of all environmental stimuli as affecting insect life. The daily activities of insects, their movements on the soil, on vegetation or in the air, are largely governed by them. And in referring to the dual influence of these stimuli it may be remarked that the various types of stimuli are very frequently coöperative. Years ago, when collecting Diptera by sweeping, Wheeler was impressed with the fact that there must be a regular diurnal up and down migration of insects in the low vegetation, comparable to the phenomenon exhibited by the pelagic fauna in the sea. The insects descend to the ground at night and with the return of light and heat rise until they reach the upper surface of the plants. There is little doubt that this diurnal migration is of economic importance and demands further careful study. Its dependence on the coöperative effect of several stimuli such as light, heat, and probably air currents, indicates the necessity, which should always be borne in mind in studying insect behaviour, of a careful analysis of tropic reactions.

The relation of the dispersion of insects to air currents is an aspect of insect behaviour that has had wide recognition since, and perhaps before, the locusts descended on the land of Pharaoh. Anemotropism is well exhibited in the case of the Rocky Mountain locust which moves with the wind and when the air current is feeble is headed away from the source. The brown-tail moth owes its distribution in New England and eastern Canada largely to wind-spread and the investigations of Collins and his associates have shown that the general spread of the gipsy moth in New England is most probably due to the fact that the first-stage larvæ are carried in a north and northeasterly direction by the warm prevailing winds rather than to dispersal by artificial means, as formerly believed. The practical value of knowledge of this type of behaviour is shown by the experiments of Le Prince and Zetek on the flight of Anopheles with the use of Quinby intercepting planes in Panama. Le Prince has suggested that where antimalarial work is to be undertaken in badly infested regions observations on the flight direction will indicate which of several possible production areas is the source of the particular species of mosquito it is desirable to eradicate.

If time permitted it would be profitable to discuss other types of tropisms and to show how this line of study throws light on the complicated instinctive behaviour of insects, particularly those exhibited

by the social Hymenoptera. The latter, however, is a subject in itself and has received the attention of more competent hands than mine; the studies of Wheeler in particular have thrown much light on this fascinating problem. As Wheeler has stated: "We know that the insect responds not only to external stimuli but also to certain unknown stimuli originating within the cells of the alimentary tract, reproductive organs, etc., and that the responses to these stimuli are often remarkably complex, as *e.g.*, in the elaborate feeding and nesting instincts of ants, bees and wasps. Nor does the complication of the problem end here. It is greatly increased by two further considerations, first, by our complete ignorance of the protoplasmic changes, chemical and physical, which precede or accompany these tropisms or the response to stimuli in general; and second, by the difficulty of explaining why all these responses are so marvelously adaptive. I venture to assert, nevertheless, that it is better to face these difficulties, insuperable as they appear, than to continue investigation in that spirit of anthropomorphism, which has been such a fruitful source of misinterpretation in the comparative study of habits and instincts."

Reference has already been made to the control of the corn root aphis (*Aphis maidi-radicis*) which is based on a knowledge of the instinctive behaviour of the ant *Lasius niger americanus*. The most notable example in applied entomology of the practical value of a knowledge of instinctive behaviour is seen in beekeeping. A knowledge of the behaviour of the bees enables us to mould their instincts along those lines most desirable from the point of view of our convenience and pecuniary profit.

Incomplete as this account is of the manner in which insects react to the various constituent factors of their environment, I trust that in the time at my disposal I have indicated the fundamental character of insect behavior in relation to the solution of the problems that confront us. We have reached a stage in the progress of our work that demands on the part of every investigator and entomological practitioner, whether he be working at problems as wide apart as taxonomy or quarantine administration, as thorough a knowledge as possible of the manifold nature of insect behaviour, that is, of the relations and reactions of insects to the physical and biological factors in their varied environments; for it is through such knowledge that applied entomologists will find solutions to some of the greatest problems that now occupy our attention and are certain to confront us in the future. Great as the contribution of entomological science to the advancement of civilization has been in the past, it is slight compared with promise of future achievement.

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VICE-PRESIDENT G. A. DEAN: It has been the policy of the Association to discuss the presidential address at the session following the one when it is delivered. If there is no objection, however, we will now have the address opened for discussion.

MR. A. D. HOPKINS: I want to compliment the President on the selection of the subject of his address and his treatment of it. The various topics relate to fundamental principles, the importance of which every entomologist should realize. The failure to consider certain general principles and natural laws in connection with our investigations has led to a waste of time in the investigation of unnecessary details and to the recommendations of methods of preventing and controlling insect attack which has led to the waste of money in unnecessary work.

We should have a better knowledge of the fundamentals and some of us should be devoting our time to the investigation of principles and laws and make the results available to those who are engaged in the investigations of the details. We cannot all investigate these broader problems but some of the older men with broad experience should do so, and they will need the sympathy and support of the other investigators when ideas and conclusions are advanced which are new or radically different from what has been accepted heretofore. There may be, and usually is something in a new idea. Let us first be sure we understand them and then test them out in practice before we discard them.

It has not been possible for the President to cover the details and it is not necessary that he should in an address of this kind. In the consideration of general principles, we must think in general, not specific, terms.

With reference to the physiological influences of the host mentioned by Doctor Hewitt, we have found, in our investigations of methods of controlling depredations by bark-beetles in the natural forests of the West, that we must consider every phase of economy as well as efficiency. We have found that the mountain pine beetle (*Dendroctonus monticolæ* Hopk.) will attack and kill the mountain pine, yellow pine, lodgepole pine, and the sugar pine, but that if it becomes established in one host species, as, for example, the lodgepole pine, through continuous attack of many generations, the beetles—when they emerge—will not attack nearby trees of any of the other host species but will show a decided preference for the species in which they bred. That is, it will not go from one host to the other in sufficient numbers to be a menace, but will take many years for it to change from one host species to another. Now, where the less valuable lodgepole pine is thickly infested and the area is surrounded by the more valuable yellow pine, which it is desired to protect, we find that we only have to deal with the infestation in the yellow pine, knowing that the infestation in the lodgepole will remain there. This we have proven in many cases of actual practice. Therefore, any money

spent in trying to dispose of the infestation in the lodgepole to protect the yellow pine would be wasted. Whether or not other species of economic insects respond in a like manner to the influence of one or more of their multiple host species, I do not know, but it is probably true with many and the determination of the facts will lead to a more economic method of dealing with them.

MR. T. J. HEADLEE: This address has drawn attention to a very interesting and important phase of our work. The feeling that the pioneer life-history work on our insects of large economic importance is approaching completion and that we should now look a little deeper has been growing. I heard from Doctor Shelford yesterday that the University of Illinois is erecting a large vivarium in which is to be installed apparatus for the conditioning of environmental factors in such a fashion that the effect of particular factors can be accurately measured. If this may be taken to indicate that the universities of the country have realized the value of determining the laws which govern the response of living matter to environmental factors and have set out to furnish facilities for collecting data, we have reason to hope that important discoveries bearing upon the phases of research mentioned by our President will not be long delayed. It seems to me that this address should be taken by our research membership to mean that the time has arrived when we must give more attention to the stimuli that influence life-history activities

MR. W. M. WHEELER: I might mention one case that recently came to my notice that has an interesting bearing on Doctor Hewitt's address and also on Doctor Hopkins' remarks. I had two students working to get a medium on which they could raise banana flies, *Drosophila*, and Doctor Glaser made a medium of banana agar and another medium with agar of potato and found that flies would oviposit on the banana agar. They were evidently attracted to the banana by a chemotropic reaction to the banana. Now if the flies were brought up on banana agar, they will also oviposit on potato agar but the larvæ will not develop readily on potato agar. There is something like memory in this matter and is somewhat similar to Doctor Hopkins' *Dendroctonus monticolæ*.

MR. A. D. HOPKINS: Mr. Craighead is carrying on many experiments at our field station at East Falls Church, Va., to determine the extent to which insect species are influenced by their host species. He has found that while *Callidium antennatum* infests a number of host species, representing different genera such as *Juniperus*, *Pinus*, *Picea*, etc., individuals breeding in one host can not be forced to even oviposit on another. He has even transferred the larvæ from one host to another but without success, while such a transfer in the same host is successful.

MR. P. J. PARROTT: I do not want to let the opportunity pass without expressing my appreciation for the address which has been given. It certainly is a clear and concise statement of the influences bearing on the response of insects to various elements in their environments. The question of insect behavior is an immense field for study and I am pleased to see the President bring out some accomplishments from studies which were problems of theoretical interest when first initiated.

MR. ERNST GRAM: This has been a very interesting address and discussion. I would like to make a suggestion in regard to the terms used. It seems that the terms chemotropic, hydrotropic, etc., were taken from the botanists. It might be more consistent to apply the terms chemotaxis, hydrotaxis, etc., in the case of insects.

PRESIDENT C. GORDON HEWITT: I thank the members of the Association for their appreciative remarks in regard to my endeavor to place this problem before the Association. I only hope that the efforts I have made will result in stimulating us to take a new and broader view of our science. I believe the great danger of economic entomology today is that we are getting down too much to a dead level and are likely to get into a rut. If we do not avoid this a great deal of energy will be lost and we shall be subjecting ourselves to an increasing amount of criticism.

I will now call for a paper by Mr. R. A. Cooley.

## THE SPINACH CARRION BEETLE

### *Silpha bituberosa* Lec.

By R. A. COOLEY, *Entomologist, Montana Experiment Station, Bozeman, Montana*

The literature of *Silpha bituberosa* is meager. The insect was described from Kansas in 1859 by John L. Leconte in his "The Coleoptera of Kansas and Eastern New Mexico" (Smithsonian Contributions to Knowledge, No. 126, page 6). In 1894, Dr. James Fletcher, in his "Report of the Entomologist and Botanist" for the year 1893, briefly discusses the species under the title "Another Vegetarian Carrion Beetle." This is a short account of the occurrence and food plants of the species together with brief notes on the life-history and is the first account of injuries by the insect that can be authenticated.

Prof. L. Bruner, reporting to Docter Riley on the "Insect injuries in Nebraska during the summer of 1892," in discussing beet insects, page 40, Bulletin 30, Old Series, Division of Entomology, states: "During my visit at Norfolk and while talking with Mr. Huxman relative to Beet Insects in general, he mentioned the fact of the injury

done by *Silpha opaca* in Germany. He said that the larva of this beetle was by all odds the most troublesome insect pest with which beet growers in that country had to deal. Hand picking was the remedy usually resorted to. He also stated that he had seen several specimens of the insect during the past summer at West Point, this State, upon sugar beets, and that he had killed them. He said that he could not be mistaken about the insect, as he had seen too many of them in Europe not to know them at sight. With this second reported presence of this insect in beet fields at this one locality it begins to appear that perhaps, after all, it is present in America."

In a letter from Prof. Myron H. Swenk, associate entomologist of the Nebraska Experiment Station, to the writer, dated November 2, 1916, we are informed that in discussing the occurrence of *Silpha bituberosa* in Nebraska with Professor Bruner, he had learned that this insect is occasionally found in that state and in beet fields and that the record of *Silpha opaca*, quoted above, probably refers to *S. bituberosa* rather than to *S. opaca*. It is also stated that the record of *S. opaca* "having been taken several times in beet fields, and in gardens where beets were growing" (Report of Nebraska State Board of Agriculture, p. 124, 1890) largely refers to *S. bituberosa*. If it were entirely certain that these records refer to *Silpha bituberosa* then we could record a somewhat earlier reference to the insect in economic literature.

In his report for 1897, Doctor Fletcher mentions this insect again and adopts as the common name "The Spanish Carrion Beetle." Doctor Fletcher states that the insect was sent to him from correspondents at Saskatoon, in Saskatchewan and from Calgary, Alberta. Doctor Horn in his "Synopsis of the Silphidæ of the United States with reference to the genera of other Countries" (Tran. Am. Ento. Soc., vol. VIII, p. 242, 1890) states that *Silpha bituberosa* "occurs from Kansas to Wyoming and Montana."

Through correspondence with official entomologists of the northwestern states, information regarding the geographical distribution of the species has been obtained. On the authority of Professors Bruner and Swenk, we have positive information of its occurrence in Nebraska and from Professor A. C. Burrill we learn that it also occurs in Idaho. From Mr. W. B. Bell, formerly of the North Dakota Experiment Station, it was learned that the insect had not been taken in North Dakota up to July, 1916. Prof. H. C. Severin, state entomologist of South Dakota, informed us that he has no record showing it to be present in his state. Prof. A. L. Melander has informed us that the insect does not occur in Washington, so far as their collections show nor had he heard of its presence in that state. Oregon likewise does not have the species, according to Professor Lovett. According to

information received from Dr. E. G. Titus, entomologist of the Utah Agricultural Experiment Station, it does not occur in Utah so far as is known. Professor Gillette informed us that he could find no record of *S. bituberosa* occurring in Colorado.

From these data it is apparent that so far as is known *Silpha bituberosa* does not occur west of the main divide of the Rocky Mountains excepting in the State of Idaho. It occurs from northern Kansas northward to Alberta and Saskatchewan. While it has not been recorded from Colorado, it is likely that it occurs sparingly in the northeastern portion of that state and likewise in the western portions of North Dakota and South Dakota.

From the records of its abundance and injuries in the North and the absence of such records for the South, it seems clear that this insect is to be looked upon as essentially a northern species. The truth of this is emphasized by the fact that the young as well as adults may sometimes be seen surprisingly early in the spring. It is quite clear that the species is a native one.

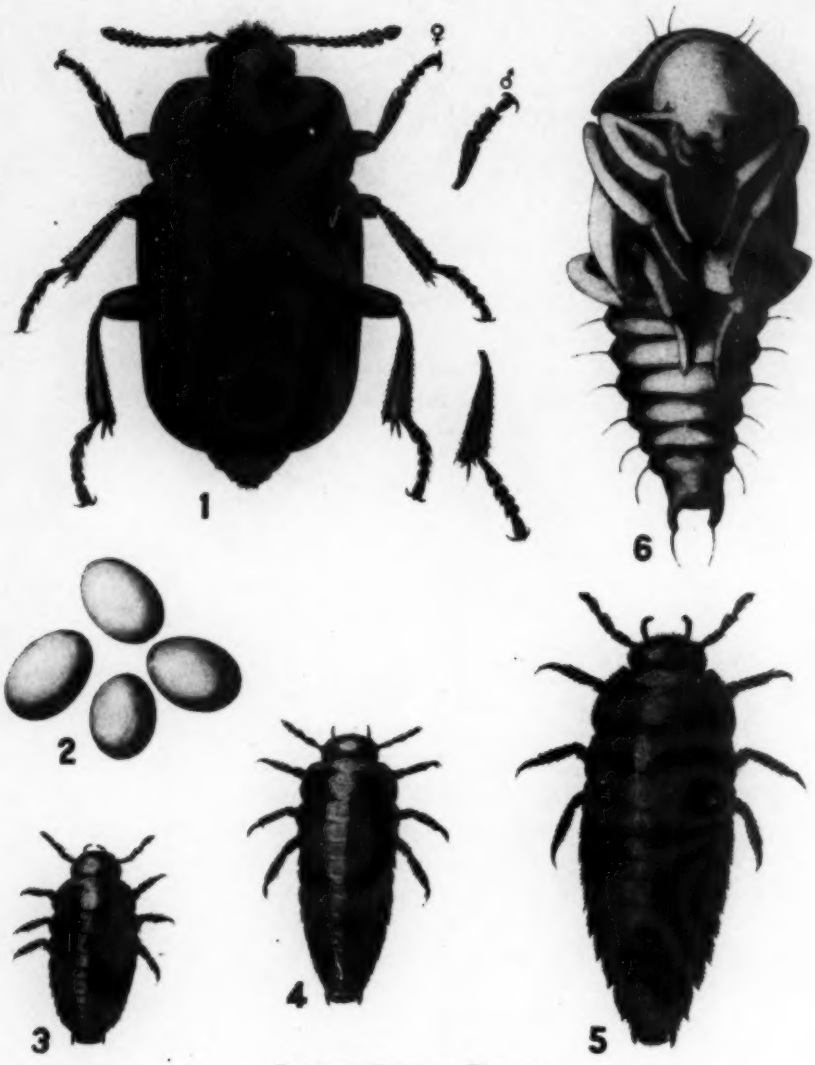
## Occurrence and Injuries in Montana

The Spinach Carrion Beetle has been collected in widely separated localities in eastern Montana and is probably common throughout the state east of the divide. At times it has been found to be very abundant and injurious in the Yellowstone Valley where the only beet sugar factory in operation in the state is located. The sugar beet is the only cultivated plant which, so far as we know, is extensively injured.

The injuries take place mainly early in May, while the plants are still very small and before the work of blocking and thinning has been done. Both the larvæ and adults may be found in abundance at this time and both are injurious, though the greater part of the damage is done by the larvæ. From observation in the insectary, it is apparent that the adults live on and feed and lay eggs for a considerable length of time and the larvæ likewise are hatching and feeding over a long period. However, the insect is injurious only while the plants are small and it is probable that the period of maximum abundance comes in the season when the beet plants are small. The injury may be scattered through the field but more often occurs around the edges where frequently the plants are completely eaten off. The insects generally migrate in from some adjoining field where some one or more of the favorite food plants occur as weeds.

### Descriptions of Early Stages

Egg:—Ellipsoidal, cream white, glistening, without surface markings in the chorion; 1.70 to 2.48 mm. in largest diameter by 1.30 to 1.97 mm. There is a considerable degree of variation both in size and shape of the egg, as shown in the illustration.




SPINACH CARRION BEETLE

1. Adult beetle. 2. Eggs. 3. First instar. 4. Second instar. 5. Third instar. 6. Pupa. All figures magnified and drawn in the same scale of enlargement.

Some are more nearly spherical than others. See Plate 5, figure 2. It has been found also that the eggs increase in size after being laid. This subject is discussed more thoroughly in another paragraph.

First Instar:—Length, 5 to 6 mm.; width of head, 1.30 to 1.80 mm.; width of body, 2.00 to 2.70 mm. All well chitinised parts, black; connecting membranes, white. Head well rounded, antennæ with three nearly equal joints, third joint with a distinct terminal sensorium beneath. Two ocelli beneath base of antennæ and group of four above. Mouthparts short and fleshy, maxillary palpi four jointed, labial palpi two jointed. The dorsal wall of the body is made up of a series of strongly chitinized, transverse plates, which project laterally and terminate posteriorly in a sharp corner. The plates of the three thoracic segments are wider than the abdominal plates, and, of these three, the anterior one is largest and the second one, intermediate in size. Segments, thirteen; segment twelve bearing a pair of two-jointed cerci. On the ventral surface, the abdominal segments, excepting the first, have transverse plates as above. The thoracic and first abdominal segments are mainly membranous. Coxæ elongated, tubular and well chitinized. Terminal segment with the dorsal and ventral walls joined, tubular. Head, including antennæ, and body, excepting membranous portions and including the legs, sparingly clothed with short bristles or spines of varying length. See Plate 5, figure 3.

Second Instar:—Length, 6.50 to 9.50 mm.; width of head, 1.70 to 2.00 mm.; width of body, 3.00 to 3.50 mm. Otherwise the second instar is like the first. See Plate 5, figure 4.

Third Instar:—Length, 11.00 to 15.00 mm.; width of head, 2.20 to 2.75 mm.; width of body, 4.80 to 5.20 mm. Otherwise the third instar is like the first and second. See Plate 5, figure 5.

Pupa:—Length 13.50 mm.; width of pronotum, 6.00 mm.; width of abdomen 5.00 mm. Entirely white, soft. Antennæ, legs and wings, free. On the anterior margin of the pronotum, on each side, are two large spines directed forward. Abdominal segments 2 to 8 inclusive, each with a long, curved bristle on each side. At the tip of the abdomen is a pair of elongations directed backward and on the tip of each is a long bristle. See Plate 5, figure 6.

## First Appearance in the Spring

The adult beetles may often be found sparingly among the first insects out in the spring. They may be seen crawling on the ground before any vegetation has started. The earliest occurrence of which we have an actual record is March 15. It is quite clear that both adults and some larvæ appear long before the sugar beet crop is planted.

## Egg Laying

The eggs are laid in the soil. A preference is shown for moist soil and the eggs may be found under the surface as deep as two inches. In depositing the eggs the insect may extend the tip of the abdomen into the soil for some depth or burrow under the surface. The female has been seen in the act of laying eggs in the field. The tip of the abdomen was extended down into cracks in the soil for the purpose. It is probable that in nature the eggs are always laid under the surface, though in the insectary, some were laid on the surface.

We have no records to show just how early egg-laying begins in the field. Larvæ have been found in abundance in Yellowstone County in the middle of April. Allowing a week for incubation and a few days more for feeding, since incubation, it is clearly indicated that egg-laying may begin early in April.

During two seasons we have carefully observed egg-laying in the insectary in large Riley type cages, which had about four inches of soil in the bottom. In 1911 this insect was kept under daily observation in the insectary from May 13 to July 25 and was occasionally examined until October 31. Adults brought in on May 18 began depositing in a few days and continued irregularly until July 10, many eggs being laid up to June 22.

In 1915, sixteen single females were kept isolated for egg-laying records. The experiment began on April 13 and continued until May 31 when one was still laying. From these records as well as from observations in the field, it is clear that the egg-laying period is long drawn out.

### Number of Eggs Laid

As stated above, individual egg-laying records were made. The largest number laid in any one day was six, while two or three was the usual number. In many instances none were laid during a twenty-four-hour period. The largest total number laid by a single female while in confinement was seventy-five and the average was thirty-nine. These beetles were captured rather early in the season, but it is almost certain that they had laid some eggs before being brought to the insectary.

### Increase in Size of Eggs During Incubation

During the course of this investigation we have had a large number of the insects in all stages under observation. The writer in some way had a suspicion that the eggs increased in size after being laid. Accordingly, individual eggs of which we had certain knowledge of the approximate time of being deposited were measured under a microscope with the aid of a filar micrometer soon after being laid and set aside to be measured again from time to time. It had been learned that it was necessary to keep the eggs in moist earth to prevent them from shrivelling. Accurate measurement records were made on fifteen eggs. Most of the eggs were measured four times. Some were measured seven times and a few only twice. Disregarding two eggs, which were allowed to go two days before the first measurement was made the increase in size ranged from 0.18 mm. by 0.25 mm. to 0.46 mm. by 0.48 mm. In a number of instances the eggs increased in size until the shorter diameter became as great as the longer diameter had been.

As they increased in size the eggs tended to become more nearly spherical though they were plump and smooth when laid. The increase in size was much more rapid soon after being laid while shortly before hatching there was practically no increase.

It was assumed that the increase was due to the absorption of moisture by osmosis.

### Incubation Period

Thirty-eight exact incubation records were made in the insectary in 1915. The maximum period was 6 days, the minimum 3 days and the average 4.76 days.

### The Larval Period

From hatching to the pupal condition the insect molts three times. Exact records of the stadia have been made, as follows: first stadium, maximum 8 days, minimum 4 days, average of 25 records, 5.08 days; second stadium, maximum 7 days, minimum 4 days, average of 10 complete records, 5 days; third stadium, maximum 18 days, minimum 12 days, average of 9 complete records, 14.66 days.

### Habits of the Larvæ

The black larvæ are rather conspicuous objects against the green leaves of the young sugar beet plants in the field. They are easily disturbed and when frightened tumble to the ground and crawl rapidly to cover under clods of soil. Much of the time is spent hidden beneath the surface. The larvæ like the adults are adapted to a variety of food plants and their presence in a sugar beet field indicates that some one or more of the favorite plants is in the neighborhood. The beet crop probably is not generally responsible for the presence of the insects in considerable numbers in a given locality. In some instances that have come under our notice the larvæ became troublesome in beet fields only after their weed hosts had been defoliated.

The larvæ prefer to feed during the night and remain in hiding in the soil during the day, but when they are abundant in a field some may be found during the day. Both the adults and the larvæ feed from the edges of the leaves and injured plants present a characteristic appearance. The mandibles appear to be poorly adapted to make clean cuts in removing bits of the foliage and the edge of a gnawed leaf often shows a thin projection of crushed tissue.

When fully grown the larva burrows into the soil to a depth of one to two inches and constructs an oval cell in which to pupate.

### Duration of Pupa Stage

All individuals forced to pupate in tin cans with insufficient earth

for forming pupal cells transformed to the adult condition uniformly in 12 days. Others that were fed over dirt and allowed to pupate in the soil emerged as adults in 23 to 26 days after disappearing into the earth. This would seem to indicate that 11 to 14 days were spent in the earth before actual pupation took place. However, the temperature in the tin cans was higher than that in the soil and this would tend to diminish the pupal period in the cans below normal. Other insectary notes which we have indicate a prepupal period of 7 to 9 days. It is probably safe to say, therefore, that in the insectary the period in the soil is about 25 days and the pupal period is about 18 days.

### Habits of the Adults

A few days after emerging the adults are indistinguishable from those that have passed the winter in hibernation and have reproduced. They are ready to eat soon after emerging and in our cages ate freely for a few days and then disappeared into the earth. They came out again from time to time and ate food but gradually spent more and more time in the soil until in the fall they were seldom seen.

### Hibernation

From the fact that we have traced the adults well into the fall and have found them very early in the spring, as well as from the fact that we have no evidence of the occurrence of larvæ or pupæ in the fall, we have concluded that this insect hibernates as adults and only as adults. It is quite certain that the adults pass the winter buried in the soil.

### Number of Broods

The complete life cycle has been accounted for at least three times in the insectary, and no evidence has been found in the field that does not harmonize with the results of insectary studies. The oviposition is long drawn out, as has been shown in a previous paragraph, and this fact readily accounts for the occurrence of larvæ during a prolonged period in the early part of summer. These facts, together with the direct evidence which we have that newly emerged adults disappear into the soil for the season without depositing eggs, make it clear that there is but one brood of *Silpha bituberosa*, at least, at Bozeman, Montana.

### Food of the Species

Dr. James Fletcher states that *Silpha bituberosa* feeds on *Chenopodiaceæ* and specifically mentions spinach and beet as host plants. He also records *Monolepis nuttalliana* (*chenopodioides*), *Chenopodium album* and squash and pumpkin, vines of which the latter two, he says,

are sometimes seriously injured. Chittenden (Bulletin 43, Bureau of Entomology, 1903) has recorded the sugar beet as being fed upon.

In Montana, we have found the insect feeding injuriously only on the sugar beet and have found both adults and larvæ feeding abundantly on *Monolepis nuttalliana* and *Solanum triflorum* and adults only on alfalfa. We have also seen the larvæ feeding in considerable numbers on young wheat. The three weeds mentioned should be looked upon as the normal food plants of this insect and the seat of the difficulty. They are weeds of cultivated fields and do not occur on soil that has never been broken.

It is not clear whether or not *Silpha bituberosa* feeds normally also on carrion. In 1910 larvæ and adults were placed with carrion in cages and as controls other species of the genus known to feed on carrion were placed in other cages under like conditions. *Silpha bituberosa* fed very sparingly, if at all. It was not seen in the act of eating while the other species ate freely. The larvæ have been seen to eat living pupæ of the same species and on one occasion one larva out of a lot that had not been given sufficient vegetable food was seen to be eating on the tail of a dead mouse.

To the writer, who has been observing the species for several years, it seems clear that both larvæ and adults feed normally on a wide variety of green vegetable foods and seldom, if ever, feed on carrion, as do other members of the genus *Silpha*. On one occasion when larvæ and adults were found to be abundant and destructive in a rather closely localized region in a field of young beets, an attempt was made to find carrion in the locality, but none could be found and the farmer stated that he did not know of any in the neighborhood.

## Remedies

From the fact that the insects commonly migrate into beet fields from weedy places near by, it is plainly indicated to be desirable to practice clean farming, keeping the vicinity of beet fields as free of weeds as possible.

At the time the larvæ and adults of this insect are injurious to beets the plants are generally quite small. Sometimes the mere seedlings are attacked. It is not feasible, then, to destroy the insects by poisoning the beet plants, unless, as is sometimes the case, the plants have become large enough to have a considerable expanse of foliage when some arsenical could probably be used effectively.

One writer has recommended that seeds of *Monolepis nuttalliana* be sown as a trap crop on which to poison the insects. The writer is not certain that this would be effective. It is feared that the insects could not be destroyed by spraying with an arsenical with sufficient

thoroughness to protect nearby sugar beets. It seems to be more desirable to recognize and destroy its favorite food plants and resort to the use of poisoned bran mash as soon as the insects are detected either on cultivated crops or on weeds.

In the season of 1915 at the suggestion of Assistant Entomologist J. R. Parker, of this office, a test of poisoned bran mash as a means of killing these insects was made at the Huntley Substation by Mr. Dan Hansen, who is in charge of the Station for the Office of Western Irrigation Agriculture, Bureau of Plant Industry, United States Department of Agriculture. Poisoned bran mash, prepared by the usual formula, was scattered among the weeds near the beet field where the insects were present in great abundance. The insects ate the mash greedily and the next day the dead insects could be found on the ground in great abundance and no living ones were seen. Mr. James Scilly, formerly agriculturist of the Billings Sugar Company, reported that he had placed the poisoned bran mash under burlap bags in the beet fields and stated that the adult beetles were attracted by the covering afforded and were killed by eating the poison.

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PRESIDENT C. GORDON HEWITT: If there is no discussion, the next paper will be given by Mr. C. H. Richardson.

## THE RESPONSE OF THE HOUSE-FLY TO CERTAIN FOODS AND THEIR FERMENTATION PRODUCTS[1]

By C. H. RICHARDSON, *College of Physicians and Surgeons, Columbia University, New York City*

Any economic study of the house-fly must obviously take into consideration the subject of food, for it is usually during its search for food that this insect is most intimately associated with man. That the house-fly has decided food preferences has already found expression in the various baits now used in fly traps. Previous studies on baits have been made largely with complex food mixtures and while they form a valuable contribution, it is felt that a more intimate knowledge of the attractive constituents of these preferred foods is highly desirable.

The experiments that form the basis of this paper were therefore conducted largely with solutions of known chemical compounds found in certain foods or their fermentation products which are eagerly sought by house-flies. They were performed at New Brunswick, N. J.,

[1] Published by permission of the Director of the New Jersey Agricultural Experiment Station.

during the summer of 1916 and form a part of a larger project on the responses of the house-fly to environmental factors undertaken by the Entomological Department of the New Jersey Agricultural Experiment Stations. (Richardson 1916.)

A study of the food preferences of this insect is beset with numerous difficulties. Temperature and light affect the abundance, but more puzzling is the great difference in numbers often noted on two consecutive days when conditions of temperature, moisture and light appear to be nearly uniform. Many explanations are offered such as the appearance of new broods, disposition to migrate and the desire to vary the diet. These conditions necessitate the repetition of all experiments as isolated tests may lead to erroneous conclusions. The data given here must be considered as a preliminary treatment of this subject, awaiting further verification and extension.

## Historical

Morrill (1914) studied the response of the house-fly to a variety of foods, some of the results of which have a direct bearing on the present investigation. Sucrose was comparatively unattractive when used in aqueous solution with formaldehyde. The addition of ethyl alcohol (95 per cent), one part to twenty parts of water, increased its attractiveness. Vinegar in combination with sucrose was eagerly sought by house-flies. This may be due to the acetic acid contained in it. Ethyl alcohol when added to beer did not form an attractive mixture. This result can probably be explained by the fact that American beers have an alcohol content close to the optimum for the house-fly. The addition of alcohol would render it less attractive. Morrill's studies point out the irregularity of response to the same bait on different days.

Buck (1915) conducted a similar series of experiments. He found that not less than 3 per cent nor more than 8 per cent of 95 per cent ethyl alcohol in water was a good bait. Sucrose was also found to be a valuable addition to various baits, sometimes increasing their attractiveness from 10 to 20 per cent.

## Methods

The experiments which are described here were performed on a shelf along the south side of a barn in a well-lighted location where flies were always plentiful. Screen-wire fly traps, 9¾ inches high and 6 inches in diameter were used in all experiments. The screen was given a coat of spar varnish to prevent rusting. White glazed earthenware dishes, 122 mm. in diameter with a capacity of 125 cc. were used as containers for the solutions. The metal trap pans and dishes were

carefully washed at the conclusion of each experiment. All solutions were made with distilled water.

The traps were placed in a linear series along the shelf three feet apart. Special care was exercised that no trap contained the same material or occupied the same position in the series in two consecutive experiments. Unless otherwise stated only one portion of a substance was used in each test.

The results given apply only to the house-fly (*Musca domestica* L.) which made up more than 95 per cent of the catches during the summer.

## Experiments with Carbohydrates

Because of the prevalence of carbohydrates in foods to which the house-fly is attracted, it was decided to test them rather thoroughly. Glucose (dextrose), fructose (levulose) and galactose were chosen from the monosaccharides; maltose, lactose and sucrose (cane sugar) from the disaccharides; and dextrin and starch from the polysaccharides. Solutions of 1 gram, 2 grams and 5 grams to 50 cc. of water were employed and 50 cc. were placed in each trap. The experiments with galactose were not completed owing to the difficulty of obtaining this compound. The results are expressed in the following table:

Experiments on Carbohydrates

| Material in 50 cc. dist. water | 1 gm. 7/12 -15 75 hrs. | 1 gm. 7/15 -18 67 hrs. | 1 gm. 7/14 -18 89 hrs. | 2 gm. 7/20 -21 28 hrs. | 5 gm. 8/23 -25 22 hrs. | 5 gm. 8/23 -25 41 hrs. | 5 gm. 8/25 -28 76 hrs. | 5 gm. 8/29 -30 20 hrs. | 5 gm. 8/30 -31 24 hrs. | 5 gm. 8/31 -9/2 45 hrs. | 5 gm. 9/2-4 47 hrs. | Total last 4 expts. | Avgs. last 4 expts. | Avgs. last 6 expts. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glucose (dextrose) | | | 3 | 1 | | | | 11 | 5 | 1 | 9 | 26 | 6.5 | |
| Fructose (levulose) | | | | | | | | 3 | 1 | 5 | 76 | 85 | 21.2 | |
| Galactose | | | 0 | 63 | | | | | | | | | | |
| Maltose | | | 1 | 14 | 2 | 21 | | 5 | 2 | 1 | 8 | 16 | 4 | 6.5 |
| Lactose | | | 0 | 0 | | 90 | 62 | 14 | 24 | 1 | 13 | 52 | 13 | 34 |
| Sucrose | | | 0 | 2 | | 7 | 6 | 2 | 2 | 7 | 2 | 13 | 3.2 | 4.3 |
| Dextrin | | | | | 2 | 23 | | 3 | 44 | 28 | 35 | 110 | 27.5 | 22.5 |
| Starch | 1 | 2 | | | | | | 1 | 2 | 1 | 5 | 9 | 2.2 | |
| Control (water) | | | 0[1] | 4[1] | | | | | | | | | | |

[1] Two traps used in experiment.

On the whole these carbohydrates in aqueous solution were not very attractive to house-flies. Considering all the experiments, lactose caught the largest number of flies (204), starch the least (12). Dextrin also caught a comparatively large number of flies (135). Sucrose was consistently a poor bait, catching but 26 flies in six experiments. From the foregoing tests, I believe it can be safely stated

that the common carbohydrates in freshly prepared aqueous solution are not eagerly sought by house-flies.

## Experiments with Alcohols and Acids

Foods containing large amounts of fermentable carbohydrates decompose with the formation of an extensive series of compounds, prominent of which are ethyl alcohol, carbon dioxide, acetic acid, lactic acid, a mixture of amyl and other higher alcohols called fusel oil and succinic acid. Of these ethyl alcohol, technical amylic alcohol (which contained a mixture of isoamyl and d-amyl alcohols, the former predominating) and acetic acid were used in six experiments and lactic and succinic acids in two experiments. Concentrations of 4 and 10 per cent were used for each compound except succinic acid. The results of these experiments follow:

Experiments on Alcohols and Acids

| Material 50 cc. | 8/28–29 22 hrs. | 8/29–30 20 hrs. | 8/30–31 24 hrs. | 8/31–9/2 45 hrs. | 9/4–7 66 hrs. | 9/7–8 30 hrs. | Total | Av. per expt. | Av. per hr. (all experiments). |
|---|---|---|---|---|---|---|---|---|---|
| 4% Ethyl Alcohol | 146 | 67 | 37 | 82 | 14 | 545 | 891 | 148.5 | 4.2 |
| 10% Ethyl Alcohol | 19 | 21 | 12 | 156 | 3 | 333 | 544 | 90.6 | 2.6 |
| 4% Amylic Alcohol (tech) | 142 | 123 | 106 | 292 | 17 | 576 | 1,256 | 209.3 | 6.0 |
| 10% Amylic Alcohol (tech) | 203 | 41 | 31 | 59 | 7 | 778 | 1,119 | 186.5 | 5.4 |
| 4% Acetic Acid | 88 | 22 | 2 | 101 | 4 | 235 | 452 | 75.3 | 2.1 |
| 10% Acetic Acid | 173 | 11 | 4 | 17 | 3 | 1,029 | 1,242 | 207 | 6.0 |
| 4% Lactic Acid | 5 | 5 | | | | | 10 | 5 | 0.2 |
| 10% Lactic Acid | 39 | 11 | | | | | 50 | 25 | 1.1 |
| 4% Succinic Acid | 64 | 12 | | | | | 76 | 38 | 1.8 |

Four per cent ethyl alcohol caught 891 flies; 10 per cent 544 flies; 4 per cent amylic alcohol was considerably more attractive, catching 1,256 flies, while 10 per cent amylic alcohol caught 1,119 flies; 4 per cent acetic acid caught 452 flies, 10 per cent 1,242 flies, or nearly as many as the 4 per cent amylic alcohol. However, a comparison of the individual experiments shows that amylic alcohol gave more consistent results than acetic acid. Four per cent amylic alcohol was more than twice as attractive as 10 per cent acetic acid in four experiments while the acetic acid was more attractive, though not twice so, in two experiments. The results with lactic and succinic acids showed some attraction in two experiments.[1]

[1] Experiments made by Barrows (1907) on *Drosophila ampelophila* Loew. (Journ. Expt. Zoöl., Vol. IV, No. 4, pp. 515–537) showed that this insect responded positively to amyl alcohol, ethyl alcohol, acetic acid and lactic acid, but that the most pronounced response was to a solution containing 2½ per cent ethyl alcohol and 5/8 per cent acetic acid.

## Experiments with Carbohydrates in Solution with Acetic Acid and Alcohols

Mixtures of maltose, lactose, sucrose and dextrin with ethyl alcohol, amylic alcohol and acetic acid were made, using five grams of the carbohydrate to fifty cubic centimeters of solution. The alcohols and acetic acid were made up in 4 per cent concentrations. The results are stated in the following table:

Experiments on Carbohydrates with Alcohols and Acetic Acid

| Material 5 gm. in 50 cc. | 8/22–23 22 hrs. | 8/23–25 41 hrs. | 8/25–28 76 hrs. | Total | Av. per Expt. | Av. per hour |
|---|---|---|---|---|---|---|
| Maltose and dist. water | 2 | 21 | | 23 | 11.5 | 0.3 |
| Maltose and 4% ethyl alcohol | 0 | 500 | | 500 | 250 | 7.3 |
| Maltose and 4 per acetic acid | 5 | 100 | | 105 | 52.5 | 1.6 |
| Maltose and 4% amylic alcohol (tech) | 638 | 440 | | 1,078 | 539 | 17.1 |
| Lactose and dist. water | | 90 | 62 | 152 | 76 | 1.2 |
| Lactose and 4% ethyl alcohol | | 180 | 200 | 380 | 180 | 3.0 |
| Lactose and 4% acetic acid | | 60 | 175 | 235 | 117.5 | 2.0 |
| Lactose and 4% amylic alcohol (tech) | | 270 | 450 | 720 | 360. | 6.1 |
| Sucrose and dist. water | | 7 | 6 | 13 | 6.5 | 0.1 |
| Sucrose and 4% ethyl alcohol | | 155 | 78 | 233 | 116.5 | 1.9 |
| Sucrose and 4% acetic acid | | 75 | 28 | 103 | 51.5 | 0.8 |
| Sucrose and 4% amylic alcohol (tech) | | 550 | 380 | 930 | 465.0 | 7.9 |
| Dextrin and dist. water | 2 | 23 | | 25 | 12.5 | 0.3 |
| Dextrin and 4% ethyl alcohol | 11 | 400 | | 411 | 205.5 | 6.5 |
| Dextrin and 4% acetic acid | 0 | 150 | | 150 | 75 | 2.3 |
| Dextrin and 4% amylic alcohol (tech) | 2 | 944 | | 946 | 473 | 15.0 |

In every case the attractiveness of the carbohydrates was increased by the addition of amylic alcohol, ethyl alcohol or acetic acid. Amylic alcohol was more effective when used with carbohydrate than when used alone; indeed, with maltose and dextrin it appeared to be remarkably attractive. Ethyl alcohol was more attractive with maltose and dextrin than when used in aqueous solution, but less so when used with lactose and sucrose. Acetic acid seemed to be about as attractive when used alone as when added to solutions of the carbohydrates employed in these experiments.

## Experiments with Other Food Substances

Wheat Flour:—The fact that bread has some value as a fly bait, especially when added to other mixtures, led to a study of the attractive constituents of wheat flour. Owing to a lack of time, it was not possible to carry this investigation very far.

Starch and two proteins, gliadin and glutenin make up the larger part of wheat flour. I have already spoken of the unattractiveness of starch. The present experiments concern the effectiveness of certain proteins and the water soluble portion of white flour.

By kneading white flour dough in water till practically all the starch granules are detached, it is possible to prepare a substance consisting largely of gliadin and glutenin known as crude gluten. The crude gluten cannot be entirely freed of water soluble substances by this method. Small amounts of crude gluten in water attracted only six flies, in two experiments, while equal amounts of white flour in water captured 332 flies. In view of the poor success of crude gluten it did not seem advisable to try gliadin and glutenin separately.

Solutions of the water soluble ingredients of white flour contained, besides the starch granules in suspension, a number of water soluble proteins, especially albumin and proteose, organic and inorganic salts and small amounts of many other compounds. Three traps containing solutions of 1 gram of total dissolved substance to 50 cc. of water caught 2,112 flies. In other experiments three traps containing 1.35 grams each of dissolved material attracted 225 flies and 2.5 grams in two traps, 855 flies.

Solutions containing the water soluble ingredients without starch in suspension gave with 0.1 gram concentrations in 50 cc. of water the following results: three traps a total of 4 flies; two traps a total of 2,400 flies.

The experiments indicate that there is something present in these aqueous solutions of white flour which strongly attracts house-flies. Experiments which extended over a period of 67 to 75 hours were on the whole more successful than those whose duration was shorter, 23 to 48 hours. These solutions improve on standing, apparently due to the formation of certain fermentation products.

MILK:—A few experiments were made on milk, prompted by the fact that it is a uniformly good fly bait. Fresh milk was acidified with dilute acetic acid till the caseinogen was precipitated. The liquid portion was separated from the caseinogen, which held much butter fat, by filtration. The caseinogen-fat mixture was unattractive to house-flies in two experiments. Fat-free caseinogen caught 77 flies in one experiment while butter fat (ether extract) caught only two flies.

These tests indicate that fat-free caseinogen is somewhat attractive to house-flies but are not conclusive. The experiments on carbohydrates, as already stated, show that flies are not attracted to milk sugar (lactose) in large numbers.

## Practical Application

While it was not possible to subject any of the materials used in this investigation to rigorous field tests, a few experiments indicated that the water soluble part of wheat flour, technical amylic alcohol, and molasses solution containing amylic alcohol have considerable value as fly baits. The aqueous wheat flour solution was made up with 1 gram of sodium arsenite and 4 cc. of amylic alcohol to each 100 cc., the molasses was diluted with water 1 to 2 or 1 to 3 and the same amounts of sodium arsenite and amylic alcohol were added. The materials were exposed in shallow dishes. Many flies were poisoned, but without control over the breeding places it was impossible to effect a permanent reduction in their number. It should be added that amylic alcohol has certain drawbacks. It evaporates rather quickly and is only slightly soluble in water rendering an even mixture difficult.

## Conclusions

The following conclusions are drawn from these experiments:

(1) Glucose, fructose, maltose, lactose, sucrose, starch and dextrin were not very attractive to house-flies. Lactose and dextrin caught the largest number of flies, starch the least. Sucrose was consistently a poor bait.

(2) Four per cent amylic alcohol gave better results than ethyl alcohol, or acetic acid in 4 or 10 per cent concentrations and better than 10 per cent amylic alcohol. Four per cent ethyl alcohol was better than 10 per cent, 10 per cent acetic acid gave better results than 4 per cent. Succinic and lactic acids showed some attractive qualities in two experiments.

(3) Maltose, lactose, sucrose and dextrin in 4 per cent solutions of amylic alcohol, ethyl alcohol and acetic acid were more frequently visited by house-flies than the corresponding aqueous solutions. Maltose and dextrin solutions were more effective than lactose or sucrose. The order of response to the alcohols and acetic acid containing carbohydrate was the same as that for the aqueous solutions of these compounds.

(4) Crude gluten from wheat flour was not attractive. The water soluble portion with or without starch in suspension was decidedly attractive.

(5) Several experiments with milk indicate that fat-free caseinogen is attractive while butter fat is not.

(6) Experiments indicate that aqueous solutions of wheat flour and molasses to which sodium arsenite and amylic alcohol are added have considerable value as poisoned baits for house-flies.

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PRESIDENT C. GORDON HEWITT: This paper is now open for discussion.

MR. MAX KISLIUK, JR.: In the Bureau of Entomology during the summer of 1915, Mr. Hutchinson and I performed several baiting experiments similar to the ones reported by Mr. Richardson. Among some of the materials used was blood of pigs secured from a slaughter-house. We tested sample traps and found that pig blood was very attractive—more so than any other material tried. Its odor, however, is very disagreeable to man, although it apparently attracts flies very strongly.

PRESIDENT C. GORDON HEWITT: The next paper will be read by Mr. W. E. Britton.

## RECENT ANTI-MOSQUITO WORK IN CONNECTICUT

By W. E. BRITTON, *New Haven, Conn.*

At the Cleveland meeting of this Association, four years ago, the writer presented figures showing that in 1912 some 2,697 acres of salt marsh in Connecticut were ditched to prevent mosquito breeding (See JOURNAL OF ECONOMIC ENTOMOLOGY, vol. 6, p. 89).

In 1913 a contract was awarded for the elimination of all mosquito-breeding places in Greenwich from the shore inland for a distance of about two and one-half miles, at a cost of $15,500. The major portion of the work related to inland breeding places such as fresh water swamps, the overflow from springs, and surface pools, but a small portion consisted of tide-water marsh which was ditched. The work was not finished until 1914.

Greenwich was formerly a malaria ridden community; it has been unofficially estimated on good authority that 900 cases of malaria occurred there in a single season. In 1914 up to September it was reported that there had been only 36 cases, of which only 15 were new ones. Since, according to several reports, there has been no malaria in Greenwich except a few hold-over cases. At any rate it seems to be

generally understood that this anti-mosquito work has had a most marked effect in reducing malaria in the town.

In the year 1914 about 310 acres were ditched on the Hammonasset salt marsh in the town of Madison.

The General Assembly of 1915 enacted a law giving the Director of the Agricultural Experiment Station authority, whenever funds have been raised for the purpose, to order mosquito-breeding eliminated in any swamp or marsh, and when the work has been done and duly approved by him, the town must maintain it afterwards. Unfortunately this measure carries no appropriation, so that the money must be raised in some other way before any work can be started. So far practically all ditching on the salt marshes in Connecticut has been done from money raised by voluntary contributions. In one or two cases small municipal appropriations have been made.

In 1915 a small area of about four acres in New Haven was ditched late in the season. But the season just closed has proved to be the banner year for ditching salt marshes in Connecticut, and the work done involves about 2,900 acres. A large portion of this acreage was ditched by contract,—the largest contract of its kind ever executed in Connecticut—including all salt marshes between Branford river and Hammonasset river. This covers a distance of about fifteen miles in a straight line, or following the sinuosities of the coast, about twenty miles. It includes all salt marshes in the towns of Madison and Guilford, more than half of such area in Branford, and a few acres in Clinton, or a total of about 2,668 acres. The cost was about $20,000.

In Saybrook during September ditches were cut in two small areas of salt marsh totaling about one hundred and fifty acres, and during October and November, a small tide marsh of about ninety acres in Orange, near New Haven, was ditched.

Thus of the total area of 22,264 acres[1] of tide-water marsh in Connecticut, several hundred acres must have been filled by electric and steam railroad companies, for freight yards and docks, by cities and towns for highways, by individuals and corporations for building sites. More than 6,000 acres, or apparently about one third of the remaining salt marsh area has already been ditched. All ditches cut in 1912 and since have been maintained in workable condition.

Bills are now being prepared for presentation to the convening legislature providing for the extension of the ditching system to cover all salt marshes in the state within a period of, perhaps, six years. Legislation will also be sought providing for state supervision of maintenance work, one half the cost being charged to the towns in which the marsh areas are situated.

[1] D. M. Nesbit, Miscellaneous Special Report, No. 7, The Tide Marshes of the United States, U. S. Department of Agriculture, 1884.

In addition to the tide-water marshes mentioned, several inland areas have been rendered immune as regards the breeding of mosquitoes. For instance, in the town of Hamden near New Haven, some swampy land is owned by the New Haven Water Company and the Winchester Repeating Arms Company. The latter is now building a dam and pumping station by means of which the water from about fifty acres of land owned by this corporation may be pumped over the dam into Lake Whitney. By raising the dam of this lake 18 inches the New Haven Water Company will flood about fifty acres of its own land. This treatment will prevent the breeding of mosquitoes on about one hundred acres of fresh-water swampy land, now a prolific source of malaria mosquitoes.

Several projects are now under way for work next year. The city of New Haven, for instance, has appropriated $10,000 for the purpose of ditching all remaining marshes within its limits.

It is evident, therefore, that Connecticut is making some progress in solving her mosquito problems.

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PRESIDENT C. GORDON HEWITT: If there is no discussion, we will now listen to a paper by Mr. E. N. Cory.

## THE PROTECTION OF DAIRY CATTLE FROM FLIES [1]

E. N. CORY, *College Park, Md.*

In 1914 the herdsman of Maryland Agricultural Experiment Station requested the writer to recommend a spray suitable for protecting the dairy cattle from flies. A spray of 6 per cent emulsion of pine tar creosote was recommended and used with excellent results for the balance of that season and during the following summer. Previously, proprietary coal tar products had been used, but several complaints had been received to the effect that the butter made at the Station was very perceptibly tainted with the coal tar odor. No complaints were made of a similar nature after the pine tar creosote was adopted. Personal examination of the butter showed no trace of creosote odor.

In 1916, a project was outlined with the object of ascertaining the minimum effective strength of pine tar creosote emulsion and the best spraying procedure with special emphasis on the length of time a single spraying was effective and the comparative value of morning and afternoon sprayings.[2]

[1] Contribution from the Entomological Department of the Maryland Agricultural Experiment Station.

[2] This project is in coöperation with the Department of Animal Husbandry of the Maryland Agricultural Experiment Station.

The emulsion was made by using ¾ lb. of caustic soda, 98 per cent pure, dissolved in a known quantity of water, for every gallon of pine tar creosote to be emulsified, and the subsequent dilution with cold water to the desired strength. This emulsion is very stable and slightly alkaline.[1]

In the preliminary tests, the herd was divided into two equal lots; one being sprayed with 1 per cent emulsion, and the other lot, with 2 per cent emulsion.

The herd was sprayed each afternoon just prior to milking (about 3 p. m.), and notes made of the effect on fly prevalence, the effect of the spray on flies actually hit, and the effect on the hide and exposed mucous membrane.

This test ran for three days and then 3 per cent and 5 per cent emulsions were substituted for a test of three days' duration.

Immediately after the application, all flies left the cattle or fell to the floor. Some few returned to parts of the animals that were not touched by the spray, through careless work. However, for the time, the cattle were approximately fly-free, and remained so until they were again turned out to pasture.

The best indication of the effect of the spray was in the cessation of the switching of tails, which, previous to the spraying, were in constant motion.

The flies that were hit, fell to the ground in a more or less bedraggled condition. Some recovered after 10 to 12 hours, confined in a wire cage, though most of those that fell to the floor were killed by all the strengths of the emulsion. The 3 and 5 per cent emulsions killed all flies that were thoroughly wetted.

Throughout the duration of the experiments, very careful daily examinations failed to reveal the slightest damage to hair or skin or to the exposed mucous membranes of the eyes or nostrils.

At first the cows were afraid of the spray when directed at their faces, but, later, many became used to the spray and hardly moved during the application.

The preliminary tests showed 3 per cent emulsion to be the most effective minimum strength, and this was adopted in the subsequent tests.

Using 3 per cent emulsion, one third of the herd was sprayed every day; one third, every other day; and the balance, every third day, to ascertain the lasting quality of the emulsion.

It was found that the mixture was fully effective only one day,

[1] This formula was supplied by Mr. C. D. Vreeland, then of the Vreeland Chemical Company. The pine tar creosote has since been obtained for us by the same gentleman through the Kilton Chemical Company.

though there was considerable protection afforded for two and even three days. To accord full protection, the cows should be sprayed each day.

In the third phase, the comparative value of morning and afternoon applications was tested. The cows were sprayed between 3 and 4 a. m. prior to milking, and were then turned out to graze. Observations in the field during this period showed the cows to be very little troubled by flies, and grazing or resting quietly. When they came in to be milked, there were few flies on the animals. The cows were quiet during the milking and did not exhibit the extreme nervousness displayed prior to the spraying.

The fourth test consisted of taking the records of the herd, half of which was sprayed once a day in the morning, with 3 per cent emulsion, and the balance left unsprayed. These notes are of a preliminary nature, and afford a possible index of what may be expected. The future tests will be on farrow cows, so maintained for a sufficient period to yield results. The indications from the preliminary records are that an increased average yield should result from protection from flies. Such an increase was obtained in this test.

The cost of the spraying was less than one-half cent per cow per application.

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PRESIDENT C. GORDON HEWITT: This paper is open for discussion.

MR. T. J. HEADLEE: Are there any figures on the increased yield of milk? The treatment costs half a cent a day per cow. What is the benefit?

MR. E. N. CORY: We know that our results are open to several experimental errors. The cows selected were hardly a representative lot, and yet comparing the record of the ten days prior to spraying with the ten days during the spraying period, we found there was an average increase of three pounds of milk per animal. The work next year will be continued over a longer period and we hope to get more definite figures on milk production.

MR. R. A. COOLEY: What were the species of flies concerned?

MR. E. N. CORY: The principal flies were the horn-fly, *Hæmatobia serrata* and the stable fly, *Stomoxys calcitrans*.

PRESIDENT C. GORDON HEWITT: The point raised by Doctor Headlee is an important one in connection with all these experiments on insects affecting cattle. Everyone knows how difficult it is to convince the farmer to undertake any very unusual measures for control of insects affecting his cattle, and he has to be convinced and convinced very strongly that good results will follow. Unless you have actual figures in regard to the effect of the flies on the cattle, without repel-

lents and with repellents, you are likely to have a very difficult task in persuading farmers to use them, even though you are perfectly convinced that they are effective. I will now call on Mr. C. W. Howard to give his paper.

## INSECT TRANSMISSION OF INFECTIOUS ANEMIA OF HORSES

By C. W. Howard, *St. Paul, Minn.*

(Withdrawn for publication elsewhere)

President C. Gordon Hewitt: This is a very interesting subject to entomologists, especially those in the Western States and the paper is now open for discussion.

Mr. R. A. Cooley: I am not prepared to make any contribution on this subject but I trust Mr. Howard may receive every encouragement in his work.

President C. Gordon Hewitt: The next paper will be read by Mr. Herbert Osborn.

## THE ECONOMIC IMPORTANCE AND CONTROL OF MIRIS DOLOBRATA

By Herbert Osborn, *Columbus, Ohio*

(Withdrawn for publication elsewhere)

President C. Gordon Hewitt: If there is no discussion I will call for a paper by Mr. George G. Ainslee.

## CRAMBID MOTHS AND LIGHT[1]

By Geo. G. Ainslie, *Entomological Assistant,*
*Cereal and Forage Insect Investigations, Bureau of Entomology*

In entomological literature there are many conflicting and confusing statements concerning the value of trap lanterns and poisoned baits in reducing the numbers of night flying moths of injurious species. The efficiency of a trap lantern depends largely on the time in the life of a moth at which it can be attracted, that is, whether before, during or after the period of egg deposition. Also the number of moths appearing at light means but little unless the sex is known and, in the case of females, the condition of the ovaries. To throw some light on

[1] Published by permission of the Secretary.

these questions a series of night collections was made at the United States Entomological Laboratory at Nashville, Tennessee, during the summer of 1915. The moths of the subfamily *Crambinæ* were particularly studied.

Concerning these moths Felt states,[1] in giving the results from a series of trap lanterns operated at Ithaca, New York, in 1889 and 1892, that "an examination of the record of any species . . . will show that the greater number taken were males, except *Crambus laqueatellus* where the females were in excess. If we accept the strong probability that one male can fertilize several females the trap lantern is of little value. . . . The females fly but little before most of the eggs are laid, consequently the trap lantern as a practicable means of checking the increase of these insects is of no value." As an opposed view Osborn says[2] in speaking of *Crambus vulgivagellus* and *exsiccatus*, now known as *trisectus*, "the moths are strongly attracted to light and for *exsiccatus* at least, the attracted individuals are in large part females loaded with eggs; so, for this species, there can be no question as to the value of trap lights."

At least fourteen species of the *Crambinæ* occur at Nashville and first and last representatives of nearly all of them have been taken at light. The great bulk of the material, however, was of *Crambus teterrellus*, a very common and widely distributed species and it is to this species that the data here given and the conclusions drawn directly apply. The smaller amount of data obtained with other species agrees on the whole with these conclusions and makes them applicable to more than the single species. Indeed, it was found that the same principles held good in the case of several species not Crambids, for example, *Nomophila noctuella*, *Acrolophus popeanella*, *Xanthoptera nigrofimbria* and *Feltia subgothica* and *gladiaria*, though the data regarding these species are much more fragmentary and inconclusive than with the Crambids.

The collections were made at the strongly lighted windows of the laboratory building and at my residence adjoining, one window of which seemed particularly attractive to the moths. The lights were started at dusk and the moths collected in vials as fast as they appeared. Those taken during each 15-minute period were kept separate and the sex of each individual determined. Collections were continued throughout the night and until the lights ceased to attract because of the brightening dawn. Generally one man could make the round of the windows in the fifteen minutes but at times it required two or even three to capture all the moths as fast as they appeared. On the night

[1] Cornell Bul. 64, p. 52.

[2] Insect Life, vol. VI, p. 72.

of September 7–8 we took 7,368 moths of *Crambus teterrellus*, 468 of them in the single 15-minute period from 7.15 to 7.30. The interest and faithfulness of Mr. W. B. Cartwright, my assistant at the time, deserve mention and I am glad to acknowledge my indebtedness to him.

Collections were made on 18 full nights between the first of June and the middle of October. Collections were attempted on numerous other occasions but during the night the weather conditions became such that the moths ceased to come so none of those records are included in the present discussion. No moths of *teterrellus* appeared on October 7 or 12. On the remaining 16 full nights of collecting 19,655 *teterrellus* moths were taken, an average of 1,228 per night. The largest number taken on one night was 7,638 on September 7, and the smallest number, 7, on October 1.

*Teterrellus* is a species without distinct generations and the moths are quite uniformly abundant from the time they first make their appearance in the spring until about the end of September when they disappear for the year. Their numbers often diminish during a prolonged dry spell in the summer but increase quickly with renewed rains, these conditions seemingly having more influence on their abundance than any periodicity of generations.

Of the total of 19,655 moths taken 13,318, or 67.8 per cent, were males and 6,337, or 32.2 per cent, females. As can be seen from Chart A the percentage of males varied on different nights from 32.7 to 100. On only five nights did the number of females taken exceed the males, the total excess for the five nights being but 312. It was very soon noticed that the great majority of the females appeared very shortly after dusk, generally within an hour and that comparatively few of the males came early in the evening. After the first flight was over there was an interval of comparative quiet after which the numbers again increased but more gradually than before. This increase consisted altogether of males and continued until the totals attained were greater than during the first flight. The maximum of this second or male flight was reached generally between 11.30 and 1.30. Chart B in which the total collections for the season are graphically represented for each 15-minute period of the night shows this relation of the sexes at a glance. It will be noticed that the females have reached their peak and as suddenly subsided by 8.30, from which time there is a very uniform and gradual decrease in their numbers until daybreak. Chart C is a representation of the facts in another form. By reference to Chart D it will be seen that over 41 per cent of the females have come by 8.30. The males, on the other hand, have scarcely begun to come by 8.30, only 3.9 per cent of their total number having appeared.

The peak of the female line is reached at 7.30, that of the male line not until 12.45. Fifty per cent of the females have appeared at 9.15 and 75 per cent at 11.45, while of the males 50 per cent have not come till 12.15 and 75 per cent until 1.45. The peak representing the male flight is much broader than that of the female flight and attention is called to the fact that the female peak should be even more constricted than it is for no correction has been made for the error caused by the earlier setting of the sun later in the season. As will be seen from Chart A, the time for the collection of the first moth moved back from 8.15 p. m. on June 3 to 7.00 p. m. in late September and October. If

CHART A. SEASONAL RECORDS ARRANGED BY DATE OF COLLECTION

| Date of Collection | Temperature | | | Time of Flight | | Moths Taken | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Mean | First P.M. | Last A.M. | Total | ♂ | %♂ | ♀ | %♀ |
| June 3 | 69 | 60 | 63.3 | 8.15 | 3.30 | 64 | 35 | 54.7 | 29 | 45.3 |
| July 22 | 65 | 55 | 58.8 | 7.45 | 3.45 | 609 | 528 | 86.7 | 81 | 13.3 |
| 26 | 75 | 63 | 69.4 | 7.45 | 4.00 | 460 | 179 | 38.9 | 281 | 61.1 |
| 30 | 81 | 72 | 77.4 | 8.00 | 4.00 | 211 | 79 | 32.7 | 132 | 67.3 |
| Aug. 3 | 73 | 63 | 68.0 | 7.45 | 4.15 | 192 | 83 | 43.2 | 109 | 56.8 |
| 10 | 70 | 68 | 68.9 | 7.30 | 4.30 | 362 | 276 | 76.2 | 86 | 23.8 |
| 13 | 74 | 66 | 68.9 | 7.30 | 4.15 | 727 | 476 | 65.5 | 251 | 34.5 |
| 17 | 76 | 70 | 72.4 | 7.15 | 4.30 | 1,344 | 917 | 63.7 | 327 | 36.3 |
| 24 | 78 | 63 | 69.6 | 7.15 | 4.45 | 641 | 285 | 44.5 | 356 | 55.5 |
| 31 | 56 | 51 | 53.9 | 7.00 | 2.30 | 185 | 97 | 52.4 | 88 | 47.6 |
| Sept. 3 | 68 | 58 | 61.6 | 7.45 | 5.00 | 5,253 | 3,789 | 72.2 | 1,464 | 27.8 |
| 7 | 75 | 62 | 65.8 | 6.45 | 5.15 | 7,638 | 5,501 | 72.0 | 2,137 | 28.0 |
| 14 | 76 | 67 | 70.9 | 6.45 | 4.45 | 1,660 | 879 | 53.0 | 781 | 47.0 |
| 16 | 80 | 68 | 72.3 | 7.00 | 4.45 | 394 | 180 | 45.7 | 214 | 54.3 |
| 28 | 72 | 62 | 65.3 | 7.00 | 3.45 | 8 | 7 | 85.5 | 1 | 14.5 |
| Oct. 1 | 65 | 55 | 60.7 | 7.00 | 4.30 | 7 | 7 | 100.0 | 0 | 00.0 |
| Total | | | | | | 19,655 | 13,318 | 67.76 | 6,337 | 32.24 |

the time of the female flight be counted from sunset instead of by the clock, the maximum flight will be found to come on the average 30 minutes after it becomes dark enough for the light to attract, while in the chart it is spread over an interval of an hour and a quarter, from 7.15 to 8.30.

As a practical application of these facts it can be seen that a trap lantern run from dusk until say 10.00 p. m., an average of three hours, will capture over 60 per cent of the female moths that would be taken in the entire night at an expense for fuel or current of about one-third what it would cost to run the lights throughout the night. These observations also explain the apparent discrepancy between the statements of observers as to the sex of moths coming to light, for it is clear

that a much larger proportion of females will be taken in collections made during the evening and early night than will appear in the material taken by a trap light run all night.

In Chart A are tabulated the data obtained as to the effect of temperature on the flight of these moths. We do not know what meterological condition determines their attraction to light but we have

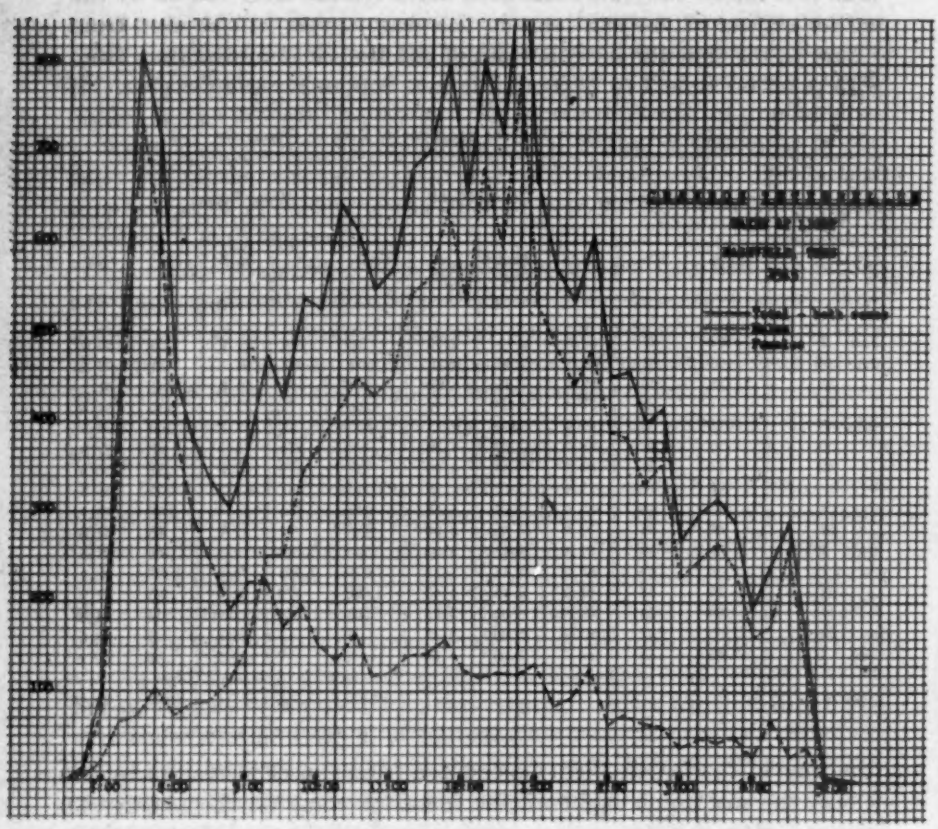

Fig. 2, Chart B. Total collections for 1915, arranged by hours of collection.

repeatedly noticed that it does not depend on temperature. If the records listed in Chart A be ranked in order by the mean temperature for the night it will quickly be seen that there is no correlation whatever between the temperature and the number of moths taken. We have several times observed two successive nights closely similar as to temperature and weather conditions, on one of which the moths swarmed at lights and on the other, few or none appeared, although

a little search with a flash lamp showed the moths to be present and even flying about over the lawn within a few feet of lighted windows. Neither does the humidity seem to bear any relation to the attraction to light. It has been suggested that barometric pressure may be

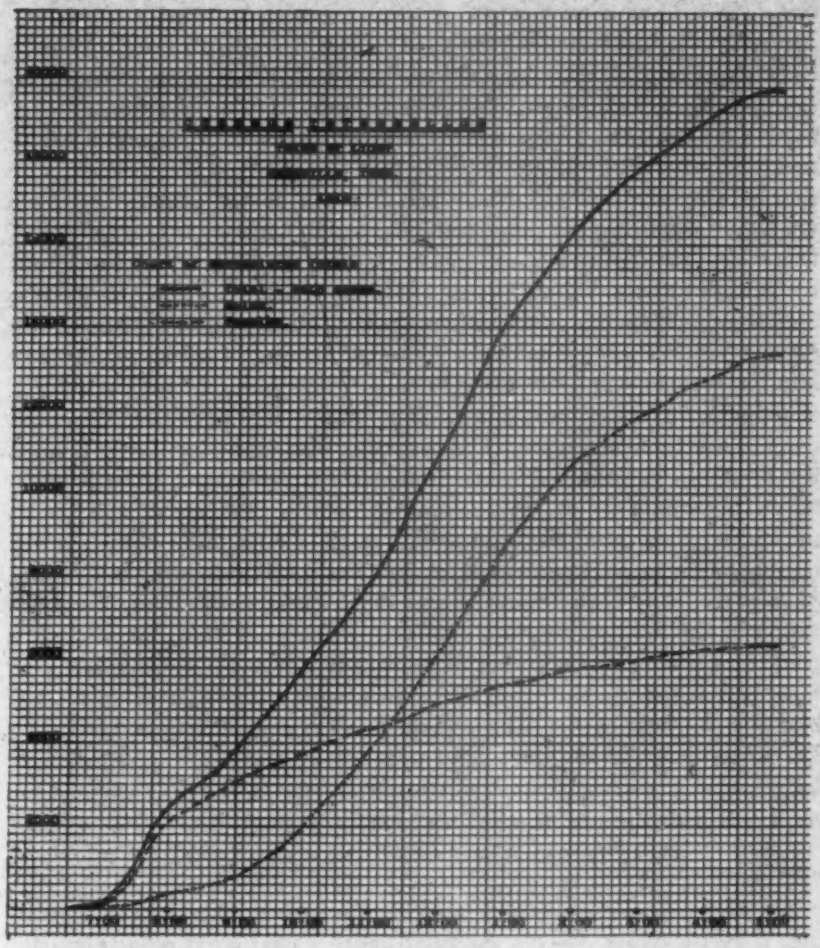

Fig. 3, Chart C. Accumulated totals of collections for 1915, arranged by hours of collection.

correlated, but no records of that were kept in connection with these collections.

The next question that arises is as to the condition of the ovaries of the females that come to light. It is assumed that the capture of the male moths is of no importance for there is little doubt, but that

the males are polygamous and their number is always sufficient to provide for the fertilization of all the females. Mating as a rule takes place very shortly after the emergence of the females from the pupa and almost invariably before they come to light, for of the large number of females taken at light and confined, a practically negligible number failed to produce fertile eggs.

Dissections of ovaries of females of several species including *teterrellus* have shown that at the time of emergence of the moth from the pupa each of the eight ovarian tubes contains about ten fully formed eggs ready for fertilization and about twenty-five more in process of development. Leaving out of account the fact that, with some species, more egg cells may and undoubtedly do develop as the mature eggs are voided, the number of theoretically possible eggs from one female of this species is about two hundred and eighty. This is well borne out by actual records. The largest number of eggs recorded from one female of this species is 323, these from a moth reared and mated in captivity. They were laid at the following rate: 132 the second day after emergence, then successively 79, 50, 43, 17 and 2, the moth dying the eighth day after emergence. The largest number of eggs secured from a moth taken in the field was 268, the largest number from a moth taken at light 250, this number being obtained from a moth taken in copula at a lighted window. From the great number of individual records of egg-laying moths it is concluded that a moth laying 200 or more eggs in confinement has not laid before the evening of capture, and is therefore practically a fresh moth. Of 76 moths taken in the field whose detailed egg records were kept, 16, or 21 per cent, laid over 200 eggs each after capture. Of 179 moths taken at light at various times throughout the season, only 8, or 4.5 per cent, laid over 200 eggs each. The average number of eggs obtained from the 76 moths taken in the open field was 117, of the 179 moths taken at light, 69. These figures all unite in pointing to the conclusion that moths of this species usually have laid a large part of their normal number of eggs, probably about 75 per cent, before they are attracted to light.

Do these moths, especially the females, feed after emergence and can they be attracted to a poisoned bait? This point was tested by several experiments conducted in different ways but along the same general lines. As the results are very similar it will suffice to give the details of one. Seventy-five female moths taken on one evening at light were placed individually in 2-ounce tin salve boxes in three sets. The boxes of set A were left empty and dry, those of set B were supplied with a small wad of absorbent cotton fastened to the inside of the cover with a drop of melted paraffin and kept saturated with water,

CHART D. DETAILED DATA ARRANGED BY TIME OF CAPTURE SHOWING RELATION OF THE SEXES

| Time | Total Moths | | | | Males | | | | Females | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period Ending | Total Moths | % of Total Moths | Accumulated Totals | | Total Moths | % of Male Moths | Accumulated Totals | | Total Moths | % of Female Moths | Accumulated Totals | |
| | | | Moths | Per cent | | | Moths | Per cent | | | Moths | Per cent |
| 6.45 | 12 | .06 | 12 | .06 | 3 | .02 | 3 | .02 | 9 | .14 | 9 | .14 |
| 7.00 | 96 | .48 | 108 | .54 | 19 | .14 | 22 | .16 | 77 | 1.21 | 86 | 1.35 |
| 7.15 | 373 | 1.90 | 481 | 2.44 | 67 | .50 | 89 | .66 | 306 | 4.83 | 392 | 6.18 |
| 7.30 | 813 | 4.23 | 1,294 | 6.67 | 74 | .56 | 163 | 1.22 | 739 | 11.66 | 1,131 | 17.84 |
| 7.45 | 715 | 3.63 | 2,009 | 10.30 | 105 | .79 | 268 | 2.01 | 610 | 9.62 | 1,741 | 27.46 |
| 8.00 | 452 | 2.30 | 2,461 | 12.60 | 73 | .55 | 341 | 2.56 | 379 | 5.98 | 2,120 | 33.44 |
| 8.15 | 378 | 1.92 | 2,839 | 14.52 | 88 | .66 | 429 | 3.22 | 290 | 4.58 | 2,410 | 38.02 |
| 8.30 | 332 | 1.68 | 3,171 | 16.20 | 91 | .68 | 520 | 3.90 | 241 | 3.79 | 2,651 | 41.81 |
| 8.45 | 305 | 1.55 | 3,476 | 17.75 | 111 | .83 | 631 | 4.73 | 194 | 3.06 | 2,845 | 44.87 |
| 9.00 | 370 | 1.88 | 3,846 | 19.63 | 150 | 1.13 | 781 | 5.86 | 220 | 3.47 | 3,065 | 48.34 |
| 9.15 | 478 | 2.43 | 4,324 | 22.06 | 253 | 1.90 | 1,034 | 7.76 | 225 | 3.55 | 3,290 | 51.89 |
| 9.30 | 426 | 2.17 | 4,750 | 24.23 | 253 | 1.90 | 1,287 | 9.66 | 173 | 2.73 | 3,463 | 54.62 |
| 9.45 | 539 | 2.74 | 5,289 | 26.97 | 343 | 2.58 | 1,630 | 12.24 | 196 | 3.09 | 3,659 | 57.71 |
| 10.00 | 527 | 2.68 | 5,816 | 29.65 | 376 | 2.82 | 2,006 | 15.06 | 151 | 2.38 | 3,810 | 60.09 |
| 10.15 | 643 | 3.27 | 6,459 | 32.92 | 509 | 3.82 | 2,515 | 18.88 | 134 | 2.11 | 3,944 | 62.20 |
| 10.30 | 616 | 3.13 | 7,075 | 36.05 | 451 | 3.39 | 2,966 | 22.27 | 165 | 2.60 | 4,109 | 64.80 |
| 10.45 | 547 | 2.78 | 7,622 | 38.83 | 431 | 3.24 | 3,397 | 25.51 | 116 | 1.83 | 4,225 | 66.63 |
| 11.00 | 573 | 2.91 | 8,195 | 41.74 | 452 | 3.39 | 3,849 | 28.90 | 121 | 1.91 | 4,346 | 68.54 |
| 11.15 | 684 | 3.48 | 8,879 | 45.22 | 544 | 4.09 | 4,393 | 32.99 | 140 | 2.20 | 4,486 | 70.74 |
| 11.30 | 704 | 3.58 | 9,583 | 48.80 | 561 | 4.21 | 4,954 | 37.20 | 143 | 2.25 | 4,629 | 72.99 |
| 11.45 | 802 | 4.08 | 10,385 | 52.88 | 643 | 4.83 | 5,597 | 42.03 | 159 | 2.51 | 4,788 | 75.50 |
| 12.00 | 658 | 3.35 | 11,043 | 56.23 | 533 | 4.00 | 6,130 | 46.03 | 125 | 1.97 | 4,913 | 77.47 |
| 12.15 | 804 | 4.09 | 11,847 | 60.32 | 686 | 5.16 | 6,816 | 51.19 | 116 | 1.83 | 5,029 | 79.30 |
| 12.30 | 720 | 3.67 | 12,567 | 63.99 | 597 | 4.48 | 7,415 | 55.67 | 123 | 1.94 | 5,152 | 81.24 |
| 12.45 | 908 | 4.62 | 13,475 | 68.61 | 789 | 5.92 | 8,204 | 61.59 | 119 | 1.88 | 5,271 | 83.12 |
| 1.00 | 669 | 3.39 | 14,144 | 72.00 | 536 | 4.03 | 8,740 | 65.62 | 133 | 2.10 | 5,404 | 85.22 |
| 1.15 | 575 | 2.93 | 14,719 | 74.93 | 489 | 3.67 | 9,229 | 69.29 | 86 | 1.36 | 5,490 | 86.58 |
| 1.30 | 535 | 2.72 | 15,254 | 77.65 | 442 | 3.32 | 9,671 | 72.61 | 93 | 1.47 | 5,583 | 88.15 |
| 1.45 | 611 | 3.10 | 15,865 | 80.75 | 485 | 3.64 | 10,156 | 76.25 | 126 | 1.99 | 5,709 | 90.14 |
| 2.00 | 453 | 2.30 | 16,318 | 83.05 | 389 | 2.92 | 10,545 | 79.17 | 64 | 1.01 | 5,773 | 91.15 |
| 2.15 | 459 | 2.33 | 16,777 | 85.38 | 384 | 2.88 | 10,929 | 82.05 | 75 | 1.18 | 5,848 | 92.33 |
| 2.30 | 399 | 2.03 | 17,176 | 87.41 | 332 | 2.49 | 11,261 | 84.54 | 67 | 1.06 | 5,915 | 93.39 |
| 2.45 | 419 | 2.13 | 17,595 | 89.54 | 357 | 2.68 | 11,618 | 87.22 | 62 | .98 | 5,977 | 94.37 |
| 3.00 | 270 | 1.37 | 17,865 | 90.91 | 230 | 1.73 | 11,848 | 88.95 | 40 | .62 | 6,017 | 94.99 |
| 3.15 | 299 | 1.52 | 18,164 | 92.43 | 250 | 1.88 | 12,098 | 90.83 | 49 | .76 | 6,066 | 95.75 |
| 3.30 | 317 | 1.61 | 18,481 | 94.04 | 270 | 2.03 | 12,368 | 92.86 | 47 | .73 | 6,113 | 96.48 |
| 3.45 | 290 | 1.48 | 18,771 | 95.52 | 239 | 1.79 | 12,607 | 94.65 | 51 | .80 | 6,164 | 97.28 |
| 4.00 | 194 | .98 | 18,965 | 96.50 | 164 | 1.23 | 12,771 | 95.88 | 30 | .47 | 6,194 | 97.75 |
| 4.15 | 248 | 1.26 | 19,213 | 97.76 | 178 | 1.34 | 12,949 | 97.22 | 70 | 1.10 | 6,264 | 98.85 |
| 4.30 | 292 | 1.48 | 19,505 | 99.24 | 263 | 1.98 | 13,212 | 99.20 | 29 | .46 | 6,293 | 99.31 |
| 4.45 | 143 | .72 | 19,648 | 99.96 | 102 | .77 | 13,314 | 99.97 | 41 | .64 | 6,334 | 99.95 |
| 5.00 | 5 | .03 | 19,653 | 99.99 | 3 | .02 | 13,317 | 99.99 | 2 | .03 | 6,336 | 99.98 |
| 5.15 | 2 | .01 | 19,655 | 100.00 | 1 | .01 | 13,318 | 100.00 | 1 | .02 | 6,337 | 100.00 |
| Totals | 19,655 | 100.00 | | | 13,318 | 100.00 | 67.76% of total moths | | 6,337 | 100.00 | 32.24% of total moths | |

those of set C the same as those of B except that dilute honey was used instead of water. Thus the 25 moths of set A had no sustenance whatever, those of set B had water, and those of set C dilute honey for food. Chart E puts the result of this experiment in compact form. It will be seen that the moths of set A were out of the running from the start as they lived a total of but 37 moth-days, laid but 59 eggs each on the

CHART E. LONGEVITY AND FECUNDITY OF THE MOTHS AS RELATED TO THEIR FOOD SUPPLY

| | Group A Nothing | | | Group B Water | | | Group C Honey | | |
|---|---|---|---|---|---|---|---|---|---|
| | Eggs | Moths | | Eggs | Moths | | Eggs | Moths | |
| | | Dead | Alive | | Dead | Alive | | Dead | Alive |
| July 31 | 1,348 | 4 | 21 | 855 | 1 | 34 | 939 | 0 | 25 |
| Aug. 1 | 97 | 9 | 12 | 1,200 | 3 | 21 | 1,634 | 0 | 25 |
| 2 | 20 | 9 | 3 | 952 | 2 | 19 | 856 | 2 | 23 |
| 3 | 12 | 2 | 1 | 741 | 5 | 14 | 502 | 8 | 15 |
| 4 | 0 | 1 | 0 | 270 | 3 | 11 | 180 | 7 | 8 |
| 5 | .. | .. | .. | 85 | 3 | 8 | 4 | 3 | 5 |
| 6 | | | | 54 | 1 | 7 | 28 | 3 | 2 |
| 7 | | | | 29 | 2 | 5 | 4 | 1 | 1 |
| 8 | | | | 26 | 3 | 2 | 43 | 1 | 0 |
| 9 | | | | 39 | 0 | 2 | .. | .. | .. |
| 10 | | | | 26 | 0 | 2 | | | |
| 11 | | | | 21 | 1 | 1 | | | |
| 12 | | | | 0 | 0 | 1 | | | |
| 13 | | | | 0 | 1 | 0 | | | |
| | | | | .. | .. | .. | | | |

| | Group A | Group B | Group C |
|---|---|---|---|
| Total eggs | 1,477 | 4,298 | 4,190 |
| Average eggs per moth | 59 | 172 | 168 |
| Total moth-days | 37 | 117 | 104 |
| Average eggs per moth-day | 39.9 | 36.7 | 40.3 |

average, or 39.9 per moth-day. A moth-day is the life of one moth for one day. Sets B and C were much more nearly tied and, except for the fact that many and varied repetitions of the test bore them out, the results could hardly be considered conclusive. The moths of set B, with water only, lived 117 moth-days, averaged 172 eggs per moth, or 36.7 eggs per moth-day. Those of set C with both food and drink in the form of dilute honey lived 104 moth-days, averaged 168 eggs per moth, or 40.3 eggs per moth-day. Thus it is seen that the moths with water only exceeded either of the other two sets in longevity and in number of eggs produced. Other experiments resulted in even greater superiority for the water-fed moths over those supplied with honey. A similar test using ten males in each set resulted in 10 moth-days for set A, 72 for set B and 43 for set C.

Comparative dissections of newly emerged and spent moths show

that the abundant fat masses present in the former have completely disappeared in the latter and indicate that the moths are entirely self-sustaining, being dependent on outside food neither for bodily energy nor for the development of the immature ova present when they emerge from the pupa. Aside from an occasional individual accidentally present we have never taken Crambid moths at sugar or molasses put out for insect bait. In view of these facts it is practically certain that if the moths feed at all, it is only on dew or rain drops and that sweetened sprays would not attract them in the least from their normal menu.

We are forced to the conclusion that so far, at least, as this species is concerned, and very probably with all Crambids, neither trap lights nor poisoned baits in the form of sweetened liquids can be used successfully under normal conditions to reduce the number of these very common and secretly injurious insects. While the results as applied to them are largely negative, several new and perhaps more widely useful facts have been obtained in the course of the work and are herein presented for use by others.

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MR. E. O. G. KELLY: I would like to ask Mr. Ainslee if he has any data relative to the height of the light trap.

MR. G. G. AINSLEE: I have not. I made no experiments along that line. Our moths were not taken at light traps but at house windows where they were observed to be abundant.

PRESIDENT C. GORDON HEWITT: If there is no further discussion, we will now adjourn.

Adjournment.

*Morning Session, Saturday, December 30, 1916, 9.40 a. m.*

PRESIDENT C. GORDON HEWITT: I declare this meeting open. We will listen to the first paper by Mr. George I. Reeves.

## THE ALFALFA WEEVIL INVESTIGATION

By GEO. I. REEVES, *U. S. Bureau of Entomology*

### INTRODUCTION

The entrance of the alfalfa weevil into the United States was spectacular. The cotton boll weevil and the gipsy moth had shown the country what a calamity the importation of a foreign insect pest might be, and taught it to appreciate the gravity of such an attack upon a staple crop.

Alfalfa, the staple leguminous forage crop of the western half of the United States, is the oldest forage crop known to man. Its origin was probably in the birthplace of the human race and before the dawn of history it was grown by the Persians, who later carried it to Greece. It was brought to Spain by the Moors and to the New World by the Spaniards. It was introduced into our own Pacific Coast from Chili, and its culture has spread until the annual yield of each of the western states is reckoned in millions of dollars.

Alfalfa is grown where other crops cannot endure the rigors of climate, and under favorable conditions its growth is so luxuriant that insects have little effect upon it unless they attack it in swarms. That is what the alfalfa weevil does. After thousands of the adults which emerge in June and July each year have died from various causes during the summer and fall, there are still hundreds of thousands left to spend the winter in each acre of the fields, and enough of them survive to produce astonishing numbers of eggs. Thus the total number of larvæ and eggs present in a measured area of a certain typical field in 1913 was equivalent to 8,240,000 per acre on May 5 to 15,650,000 on May 14; to 22,920,000 on May 21; and to 10,410,000 on May 31, while on June 5 the number had sunk to 310,000 per acre, because the maturing of the larvæ outran the deposition of eggs.

The egg-laying begins in the dead stems which litter the ground, weeks before the spring growth of the plants commences, and in fact there are then many eggs remaining alive which were deposited the fall before. Oviposition in green stems begins with warm weather and increases until late in May and is so related to weather conditions that the supply of young larvæ is early and uniform in seasons when the growth of the alfalfa is of that character, and late and concentrated when the growth of the crop is late. In either case the alfalfa has no chance to mature a full crop. The larvæ feed upon nearly every leaf, and in the worst cases, completely stop the growth and consume nearly everything but the woody fibres of the plant. The hay must be cut green or abandoned. The feeding of the larvæ does not end with the attack upon the first crop; on the contrary, its effect is intensified by concentration upon the buds of the stubble so as to prevent the growth of the second crop.

This condition exists, not occasionally but every year, throughout most of the country where the weevil has become well established, including six counties which produced in 1909, according to the U. S. Census, over a quarter-million tons of alfalfa. It is a condition which is likely to spread wherever alfalfa is grown, since Salt Lake is the commercial and social center of a territory much greater than the State of Utah or even the Great Basin. There is still the hope that

the pest may prove less harmful in higher altitudes and latitudes, but that is scant comfort for alfalfa growers in regions threatened by its steady approach.

These are the reasons for the existence of the alfalfa weevil investigation. It was taken up by the Bureau of Entomology in 1910, and now employs five entomologists and a clerk. The equipment includes a one-room office, a four-room laboratory, and the usual instruments and supplies. The annual pay-roll is $8,390, the rent, $450, and other expenses, $1,500.

The practical results of the investigation have been to develop five methods of controlling the weevil, to discover and publish its occurrence in new territory and to study the factors which determine its spread. The practical control measures are flooding with sediment, spraying with arsenical poisons, pasturing, harrowing the stubble, and colonizing parasites. None of these methods is entirely perfected, and not all are equally valuable, but all are useful, and all are in actual use.

### Flooding with Sediment

Covering the field with muddy water in early spring causes a deposit of silt over the surface of the ground, which imprisons the adults and the eggs contained in dry stems. It is an effective way of protecting the crop, but it is only possible in the undesirable condition where the irrigation system is without a settling reservoir. This condition obtains in many small systems, and it is then possible to carry the muddy spring floodwater over the fields and cover them several inches deep. This practice was first seen in a field situated in a ravine at Fort Herriman, Utah, where the creek ran along one side of the field and had overflowed and covered a portion of the field with silt and gravel. The buried portion was free from weevil injury, while the rest of the field was considerably damaged. We had no authentic history of the field and were unable to show that the mud had killed the weevils, but later an experiment which had been under unusually close observation for several months was ruined by being flooded with sediment. The Utah-Idaho Sugar Company had allowed us, with the Agricultural Experiment Station, to use a field of alfalfa at Saratoga Springs which was watered by the flow from a hot spring. A series of experiments with irrigation and cultivation at different seasons of the year had been begun in the fall and carried on throughout the winter, and careful examinations of the plats made at short intervals to determine the number and condition of the weevils present under various treatments. Some of the examinations were made at times when the ground was frozen hard and had to be dug up with pick and shovel, thawed out, dried, and sifted to find the weevils. Consequently, our

knowledge of that field was unusually complete. In April the greater part of the field was inadvertently flooded with sediment, and from that time there were too few weevils in the field to answer the purpose of the experiment, while they attacked neighboring fields as usual. Since mere submergence in water has practically no effect upon the insect at any stage, ordinary irrigation is ineffectual. Similar results can be produced by dragging a muddy field, but the effect upon the soil is disastrous. Since only a limited number of fields can be flooded in the way that I have described, its usefulness is limited to that extent. Where it can be practiced it is successful.

### Spraying

Among methods of wider usefulness, spraying was one of the earliest to be considered. It was tried by the Utah Experiment Station, before the Bureau of Entomology took up the investigation, and was then reported favorably, but later discarded. It has since been further investigated and, while not yet perfected, it promises practical success.

The theory of spraying for the alfalfa weevil embraces two possibilities; namely, poisoning the old adults and new-hatched larvæ in early spring, and the full-grown larvæ and new adults in summer. Adults which have survived the winter begin to deposit eggs soon after warm weather arrives, at first confining their work to the dead stems of various sorts which litter the ground, but later ascending the green plants and ovipositing in them. Meanwhile, they feed sparingly upon the epidermis of leaves and stems and also use their beaks in preparing holes to receive the eggs. Although they consume but little tissue, they take it chiefly from the surface, and although they cease feeding after taking an amount of poison too small to produce immediate death, it causes them to cease ovipositing. It is probable that they feed also upon the dead stems. Poisoning the adults is therefore feasible and effective.

Many eggs which have been deposited unseasonably early, either in the spring or the previous fall, hatch before the main economic attack begins, and are numerous enough to constitute a separate problem. These early larvæ are easily poisoned by the same application which destroys the adults, and are prevented from hindering the more important purpose of the treatment. In these two ways, the early spraying protects the crops throughout the season, and in some measure through the following year as well, so that a successful spraying experiment sometimes renders the field unfit for similar work the next year.

The second possibility is in spraying the stubble after the first crop has been removed. It is unnecessary after a successful early spray,

and is in nearly every respect inferior to spring spraying, but in the absence of other treatment it destroys the adults and larvæ which gather upon the buds of the stubble and prevent the sprouting of the second growth.

The arsenical poisons commonly used in orchard work have been tried in various strengths and all are about equally useful. The method of application is largely a matter of convenience and economy, but there are some exceptions; for example, it seems to be necessary to use Bordeaux nozzles and consequently a greater quantity of liquid for the stubble spray in order to penetrate to the crevices around the crowns where the insects are gathered at that time. The best time for the application is determined by the weather and the convenience of the farmer rather than by the calendar. Results are best when the spraying is followed by warm, bright, quiet weather, such as produces a maximum of feeding.

The expense of the process contains a highly variable factor in the cost of labor, which depends upon the skill with which the operation is managed and the distance from which water must be hauled. It has been kept as low as 70 cents per acre, including all labor, in situations which were not especially favorable.

A possible objection that always arises when the spraying of a new crop is discussed, is the danger of poisoning the product. This has been disposed of in the present case by spraying hay which was nearly ready to cut, analyzing samples from the cocks, and feeding the hay to live stock. Without resorting to figures, the outcome may be presented by saying that the consulting chemist found less arsenic than is present in many samples of commercial baking powders. The consulting veterinarian upbraided us for running what he called a "fool experiment" in which there could not possibly be any appreciable physiological result while there might be an accidental casualty which would furnish an argument against spraying, and finally, the cows employed in the test, after a month of feeding exclusively upon poisoned hay, were so lively that it was impossible to get within kodak range for a satisfactory photograph outside the corral.

Spraying is probably a makeshift solution of this problem, and with more complete knowledge we may be able to devise a simpler process for handling the pest. At present it serves a purpose.

### Pasturing

Pasturing is free from the objection just mentioned against spraying, and it has an insecticidal value. Its limitation is in the extent of the area that can be pastured economically. Ordinary pasturing greatly reduces the number of eggs which succeed in hatching from the green

stems of the field, but it is most effective when practised in the progressive or rotation form now used by many farmers. This method, which consists in dividing the field and turning all the animals into each enclosure in turn, meanwhile allowing the others to grow up, gives a greater yield of forage than the old way, and, what most interests the entomologist, permits the weevils to place their eggs at a considerable distance above the ground, where they are almost sure to be destroyed by the live stock at their next admittance to the enclosure. Experience shows that the weevils will deposit their eggs as near the ground as they are compelled, by the shortness of the growth, to do, while there is a limit to the closeness to which animals, particularly cows, can crop their pasture. Fields which have been pastured closely therefore sometimes suffer as much from the pest as do those which are unpastured, while fields pastured in rotation almost uniformly escape with little damage to the first crop and are practically free from weevils when the stock is removed after the egg laying season. Thus the first crop is without labor and the field is, without extra expense or effort, left in condition to produce later crops of hay.

### Harrowing

In case neither spraying nor pasturing has been employed, the condition of the field after the removal of the first cutting is serious. All the larvæ and young weevils which made such inroads upon the first crop as to compel its cutting before maturity to prevent total loss, are then compelled to find food in the little sprouts upon the stubble. Although many become ineffective by pupation and many more by death from extreme heat, there are enough left to destroy all growth throughout the time usually occupied by the production of the second crop, which is thus a total loss. Any treatment of the field after the first cutting is a deplorable necessity, because that is the busiest time of the season, and labor and time are valuable, but if no earlier treatment has been applied it is simply a question of whether the crop is worth the cost of saving it.

Under such circumstances the insects can be destroyed and the crop protected by taking advantage of the fact that a temperature of 120° F. is fatal to the insects. This temperature is best produced by covering the surface of the field with something approaching a dust-mulch, unshaded by clods and vegetation. On a bright, warm day such a surface is heated by the sun enough to kill all stages of the weevil, and the dust kills many of those which escape the heat. If the field is not dry, the necessary temperature cannot be produced, and if it is too grassy, rocky or hard, the cost of the preliminary cultivation will be high. The tools used are the disc or spring-tooth harrow and some

kind of drag, and the cost is about $1 per acre. This is only nominally a cultural method, since in order to start the growth of the second crop, it must be followed by irrigation, which compacts the soil and this counteracts the cultivation. It is nevertheless a valuable method, and great credit is due the Utah Experiment Station for the principal share in developing it.

## Parasites

Several species of parasites have been imported from Europe, and one is known to have become acclimated in Utah. This Ichneumonid, a species of Bathyplectes, was liberated in an alfalfa field near Salt Lake in 1912 and several secondary colonies have been started in neighboring localities. As high as 30 per cent of the larvæ present in midsummer were found to be parasitized, and it is possible to collect parasite cocoons for wider distribution without difficulty. Outside of the artificial colonies the parasite has spread spontaneously almost as widely, and it now occurs in this way throughout the Weber Valley, which is approximately parallel to Salt Lake Valley and from ten to thirty miles distant from it. It is still too early to say how valuable the parasites will be as a means of control, but a certain amount of usefulness is demonstrated beyond doubt, and there are great possibilities. In this connection the rapid reproduction of the weevil is a consideration. Although there is but one annual generation, one half of the beetles are females, and since the number of eggs produced by each is not far below one thousand, natural causes must destroy nearly 99.8 per cent in order merely to prevent the actual increase of the species.

Several parasites which are undoubtedly native American have been reared from the alfalfa weevil, and there is a possibility that they may sometime be useful. However useful they and the imported parasites may become, the alfalfa grower must take steps to protect his crops from the pest by one of the methods which have been described.

## Spread of the Weevil

The alfalfa weevil investigation must devise new processes and adapt old ones for the control of the pest in new territory as fast as it spreads, and this necessitates a close watch of the boundaries of the infested district. It has been impossible to search the entire frontier every year, but the survey has been completed every second year, warnings have been given to the farmers and state authorities who were concerned, and preparations have been made for meeting new conditions. The weevil has now been found in three states and has entered the Pacific Slope. Scouting is the most expensive and least productive of

all the enterprises connected with the project, because it requires rapid travel over long distances during the busiest season, but it is considered inevitable. The spread of the weevil has been slow and uniform, regardless of the character of the country, whether cultivated or wild, and the evidence all indicates that it will continue so.

### Methods of Spread

The means by which the alfalfa weevil travels is rendered an important question by the quarantine regulations which Montana, Oregon, Idaho, Arizona, and California adopted in the effort to exclude it from their territory. Consequently a minute study has been made of the natural locomotion of the insect, and of commercial traffic, involving the examination of wagons, freight and express cars, warehouses and stores, together with their contents. Nearly every case of the occurrence of weevils in commerce has been traced to actual contact of the commodity with infested alfalfa hay. Weevils are found in hay hauled in wagons, in certain cars of potatoes, and in clothing worn upon trains and carried in trunks. Representatives of the states mentioned, have embodied these facts in nearly unanimous recommendations for a revision of the quarantines.

### Conclusion

These are the principal economic results of the alfalfa weevil investigation, based upon a large amount of technical work, some of which has been tedious in the performance and might prove so in the presentation. Interesting biological problems which have been encountered, and some of which have been solved, deserve ampler discussion than is possible here, while a volume could be written upon the executive obstacles which have been overcome.

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President C. Gordon Hewitt: This paper is now open for discussion.

Mr. T. J. Headlee: Is there any evidence that the alfalfa weevil will not be able to come to the eastern part of the United States and prove as damaging here as it is in the western alfalfa growing states?

Mr. G. I. Reeves: There is no such evidence. There is evidence that in high altitudes the weevil is less destructive, and there is a possibility that in a different climate from that of Utah, the weevils would not be forced into inactivity by the heat of summer, the generations would be more or less spread out, and the feeding would continue through a larger portion of the year but be less concentrated and therefore less destructive. The work of the weevil is only disastrous when

it consumes plants faster than they can grow. A small amount of pruning is no doubt good for the plants, and if the feeding which takes place in two weeks could be distributed through three months it might be very advantageous. Mr. H. S. Smith, who studied the insect in Italy, was of the opinion that that was one of the principal factors in producing the condition in Italy along the seacoast, where the weevil is always present in considerable numbers, but is of no consequence as a pest. Its feeding is distributed through many months instead of a few weeks.

PRESIDENT C. GORDON HEWITT: I will now call for a paper by Mr. A. F. Burgess and Mr. E. L. Griffin.

## A NEW TREE BANDING MATERIAL FOR THE CONTROL OF THE GIPSY MOTH

By A. F. BURGESS and E. L. GRIFFIN.[1]

About the year 1896, when the gipsy moth work in Massachusetts was in charge of the State Board of Agriculture, a small quantity of a product known as Raupenleim was imported from Germany to use for banding tree trunks to prevent caterpillars from reaching the foliage. The results with this material proved to be of enough value so that an attempt was made during the following year to manufacture it in a small way in this country. The material was of a greasy nature and was applied to the tree trunk with a trowel, the upper part of the band being thinner than the lower edge. The results with the substitute which was prepared in this country were not very satisfactory, particularly because the object of the work at that time was the extermination of the moth, and although banding was not very expensive, it was found that more caterpillars could be destroyed in a given area by using burlap and crushing the caterpillars that congregated beneath it.

When the gipsy moth work was resumed by the State of Massachusetts in 1905, the question of banding trees was a very important one. By that time tree tanglefoot had come into use and it was adopted as a satisfactory material for banding purposes and has since been used in large quantities throughout the infested area.

In 1909, Dr. L. O. Howard, while in Europe, secured a small order of Raupenleim from a German factory and shipped it to this country.

[1] The testing of the material was carried out by the Gipsy Moth Laboratory and field force of the Bureau of Entomology, while the analyses were made and material prepared at the Insecticide Laboratory, Bureau of Chemistry, U. S. Department of Agriculture.

It was applied to several species of trees by men working under the direction of Mr. D. M. Rogers. Bands about three inches wide were placed on the trees by using a wooden paddle similar to that with which tanglefoot is applied. The material did not give satisfaction, as it dried out in some parts of the band, and there was a decided tendency for it to run down the tree trunk when exposed to high temperature. It is probable that the difficulty experienced with this material was due to the method of application, but as it did not look promising further experiments were not continued.

In 1912, Mr. L. H. Worthley, while employed by the Bureau in making gipsy moth investigations in Europe, observed the successful use of Raupenleim in the German forests. He obtained a barrel of the material and had it shipped to the Bureau at Melrose Highlands, Mass. He also secured a sample of the gun used in applying the bands to the trees. This instrument consists of a tin cylinder, in one end of which is a small, somewhat rectangular orifice. Into the cylinder is fitted a plunger which can be forced forward in such a way as to slowly press the banding material through the orifice. To apply the banding material to a tree, it is simply necessary to place the orifice against the tree trunk, gradually forcing the material through while the operator moves slowly around the tree until he has encircled it. Experiments conducted by Mr. Worthley with this material during the summers of 1913 and 1914 indicated that it was very effective in preventing caterpillars from ascending the trees and that no injury was caused to the bark. Since the time these experiments were concluded, it has been impossible to obtain more of the German product.

An attempt was made in the winter of 1915 to procure a similar product in this country. Samples were sent to the Federal Insecticide Board and through the courtesy of Dr. J. K. Heywood, chairman of the board, the matter was investigated by Mr. C. C. McDonnell who detailed Mr. E. L. Griffin, one of his assistants in the Insecticide and Fungicide Laboratory, to make a special study of the material. At our suggestion, several samples were prepared having slightly different consistencies and these were tested during the winter in a chamber especially designed for the purpose, where different temperatures were maintained in order to determine whether the samples would remain intact if subjected to high temperature. The two best samples were selected and a quantity of the material was prepared for use in the field during the summer of 1915. Good results were secured, and at our request two tons each of the two samples were prepared and applied in the field during the spring of 1916. The purpose of using so large an amount was to make the test extensive enough so that definite conclusions could be drawn. The material was used in New Hampshire,

Applying tree banding material.

Gipsy moth caterpillars under tanglefoot band.

Massachusetts, and Connecticut on all kinds of trees and no injury to the trees resulted, and excellent results were secured. Many tests were also made by Mr. C. W. Collins and C. E. Hood of the Gipsy Moth Laboratory to determine the effect of using bands of different widths and thicknesses as well as to compare the results of these substances with other banding materials. One sample, however, proved better than the other on account of its being a little softer, which made it easier to handle in the guns when the temperature was low.

In gipsy moth work, banding is usually begun in April and many days the weather is rather cold. The sample which gave the best results contained the following materials.

(a) A high boiling neutral coal tar oil having a density of about 1.15 at 20°C.

(b) A soft coal tar pitch.

(c) Rosin oil of the grade known as first run "Kidney" oil.

(d) Ordinary commercial quick lime.

A stock mixture was first made up in large quantities as follows: A weighed quantity of the coal tar pitch was transferred to a ten-gallon steam jacketed kettle, which was equipped with a stirring arrangement operated by a motor, and heated until thin enough to run. Then twice its weight of the coal tar neutral oil was run in and the mixture well stirred, thus giving a product which could be poured and worked after it had cooled off. This will be referred to as the "Pitch-neutral oil mixture."

The quick lime was slaked with a small amount of water, so that the resultant product would be a dry powder. This was passed through a sieve having ten meshes to the inch.

The tree banding material was mixed as follows: 5 lbs. of the "pitch-neutral oil mixture," 16 lbs. of the coal tar neutral oil and 4 lbs. of slaked lime were weighed into the mixing kettle previously referred to, and the stirrer started working. When the contents had become of a uniform consistency, 20 lbs. of rosin oil were added and about ten minutes later 10 lbs. more of the coal tar neutral oil. At the end of twenty-five minutes from the time the rosin oil was added, the stirring was stopped and the material dumped into tubs. It was now rather thin and was allowed to stand for two days by which time it had set into a semi-solid cake. Two pounds of the coal tar neutral oil were stirred into each 50 lbs. of this mixture in order to give it the desired oily surface. The product was now ready for use.

The physical properties of the material can be varied through quite a large range by varying the proportions of coal tar neutral oil and "pitch-neutral oil mixture," and also by varying the amount of rosin oil and lime. The addition of more coal tar neutral oil makes the

material softer and more oily. Too much of it, however, gives a product which will not stand up under summer heat. A harder product can be made by the addition of more pitch or larger quantities of rosin oil and slaked lime.

The cost of the materials used (prices paid by the Department of Agriculture in the Spring of 1916) were as follows:—The high boiling coal tar neutral oil, 45¢ per gallon (about 4.7¢ per pound) and the coal tar pitch, 11¢ per gallon (about 1.1¢ per pound). They were both obtained from the Barrett Manufacturing Company, Philadelphia, Pa. The rosin oil ("Kidney" oil) was furnished by the John A. Casey Company of New York at 36¢ per gallon (about 4.32¢ per pound). The quick lime cost 65¢ per barrel of 200 lbs. (about 0.33¢ per pound). Based upon these figures the tree banding material cost 4.14¢ per pound distributed as follows: Pitch 0.03¢, Rosin oil 1.49¢, Coal tar neutral oil 2.60¢, and Lime 0.02¢. These prices do not include containers. Metal containers with bail and cover, holding 25 pounds and strong enough to bear shipment without crating will cost about 25¢ each. If the material were packed in barrels the additional cost per pound would be very small.

It is possible that a cheaper commercial coal tar distillate, such as road oil, might be substituted for the comparatively expensive coal tar neutral oil, thus bringing the cost of the material even lower.

It is evident that this material is considerably cheaper than any successful banding material that is now on the market. Pound for pound, the tree banding material will cover about two-thirds as many lineal feet as tree tanglefoot, but as the trees do not have to be scraped before applying the former band, the labor is reduced so that a large saving is made by using this material. The bands remain on the trees during the winter and can be moistened with turpentine in the spring so that they will be effctive for two seasons.

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PRESIDENT C. GORDON HEWITT: The paper is now open for discussion.

MR. W. E. HINDS: I would like to ask whether on highways where dust is abundant the effectiveness of the bands is reduced?

MR. A. F. BURGESS: The effectiveness of these bands is not reduced as much as in the case of tanglefoot bands, but they require more attention when there is an abundance of dust.

MR. P. J. PARROTT: I would like to ask if any allowance has to be made for high temperature as summer advances, or for excessive precipitation.

MR. A. F. BURGESS: No.

MR. P. J. PARROTT: We have been working on a preparation manufactured in this country for the purpose of preventing ants from carrying aphids on apple trees. One of the great defects in the material is that during seasons when rainfall is heavy, as in 1916, the ants were able to cross the bands after heavy rains.

MR. A. F. BURGESS: It is very difficult to secure a banding material which will not run when exposed to high temperature or harden after a rain. We have not had these difficulties with this material. It is more greasy than sticky.

PRESIDENT C. GORDON HEWITT: I will now call on Mr. E. D. Ball to present his paper.

## EFFICIENCY AND ECONOMY IN GRASSHOPPER CONTROL

By E. D. BALL, *State Entomologist, Madison, Wis.*

That grasshopper outbreaks can be successfully controlled is a definitely established fact. That they will ordinarily be controlled under every day farm conditions is still very doubtful.

Where organized campaigns are waged against large outbreaks, public sentiment aroused, poisonous material supplied in carload lots, and distributed to those needing it, it will always be easy to obtain a high percentage of effort and a still higher percentage of efficiency. Whether the material is sold or furnished free makes little difference, so long as it is readily available and sufficient publicity has been given to arouse interest to the point of action.

Under ordinary farm conditions the handling of an outbreak is quite a different matter. The danger of damage is often realized, but the material for destruction is not at hand and often difficult to procure. The writer has several times been in communities in which it was found practically impossible to procure any strong smelling molasses,—either West India or Sugar Beet, without which the effectiveness of the poison bait is much reduced.

The Hopperdozer as usually built and operated is not very efficient and requires tar or crude oil, neither of which may be available, though kerosene may be used as an expensive substitute. Its operation in any case is disagreeable and a constant expense, and the machine is so offensive that it is almost always left outside to rust or rot.

The grasshopper catching machine is the easiest solution of many of these problems. It is efficient, inexpensive and when once built is always ready for immediate use. Communities that have once been supplied with grasshopper machines rarely call for additional help.

The first cost of a machine is less than the cost of treating forty acres with poison once, and the same publicity that will arouse a community to action in the line of poisoning mixtures will get the machines built.

The cost of treating one hundred acres by each method, using average fluctuations in prices previous to the war, will give a better idea of the problem.

COST OF APPLICATION OF POISON BRAN MASH PER 100 ACRES

| | *Low* | *High* |
|---|---|---|
| 500 lbs. bran @ $20–$25 per ton | $5.00 | $6.25 |
| 20 lbs. Paris green @ 30¢ | | 6.00 |
| or 20 lbs. white arsenic @ 10¢ | 2.00 | |
| 12 gal. molasses | 6.00 | 12.00 |
| 10 doz. oranges and lemons | 2.50 | 4.00 |
| Total cost of material | $15.50 | $28.25 |
| Labor, mixing and sowing 5 days @ $2–$2.50 | 10.00 | 12.50 |
| Total cost of treatment | $25.50 | $40.75 |
| Cost per acre—one application | .25 | .40 |

COST OF MACHINE AND OPERATION ON 100 ACRES

| | *Low* | *High* |
|---|---|---|
| 15 sheets tin, 20 x 30, @ 20–25¢ | $3.00 | $3.75 |
| 64 sq. ft. wire netting @ 3–5¢ | 2.00 | 3.20 |
| 80 ft. of inch lumber @ $20–$40 | 1.60 | 3.20 |
| 32 board ft. of 2 x 4 @ $25 | .80 | .85 |
| Nails, bolts, hinges, catches, etc. | .60 | 1.00 |
| Total cost of material | $8.00 | $12.00 |
| Labor, building | 3.00 | 6.00 |
| Total cost of machine | $11.00 | $18.00 |
| 2½ days—man and team running machine | 9.00 | 12.00 |
| | $20.00 | $30.00 |
| Cost per acre | .20 | .30 |
| Cost per acre (later treatment) | .09 | .12 |

From these tables it will be seen that the cost of one application of poison bait will vary from 25 to 40 cents per acre, while the cost of a machine for the same acreage would only amount to 20 to 30 cents per acre, and you would *have the machine* left for future use, so that later treatments would only cost from 9 to 12 cents per acre, where poison bait would cost from 25 to 40 cents.

Studying these tables from the standpoint of cash outlay, which is often of great importance to the farmer, it will be seen that the treatment of 100 acres by poison would require a cash outlay of from $15.50

to $28.25 while the total cash outlay necessary for a machine would be from $8 to $12. Even this amount could be materially reduced by using material at hand for the frame of the machine and oilcloth in place of the tin. The writer in an emergency case once built one of these machines in four hours and constructed it entirely from waste material found in the farmer's yard.

The relative efficiency of the two methods is probably about the same. There are weather conditions in which poisoning is difficult—winds and frequent showers among the worst. There are other conditions in which the machine is not successful—extremely hot days and

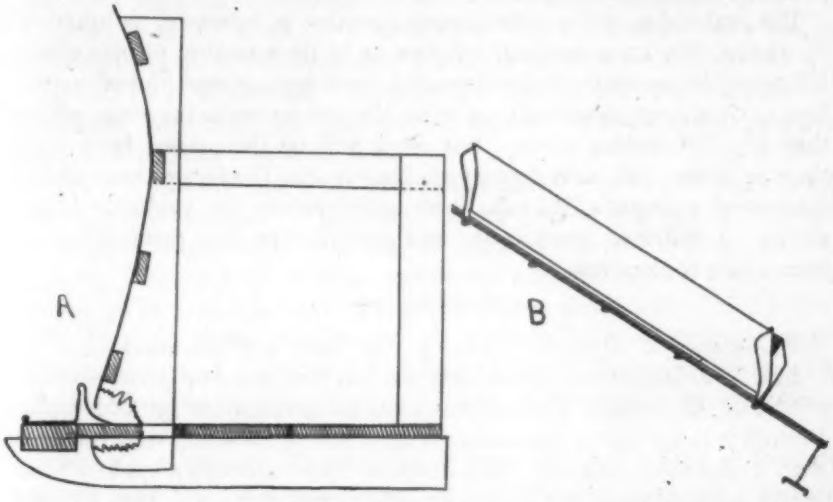


Fig. 4. *A*. An end view of the grasshopper machine showing construction. (Front upright cut out to show curve of catching device.) *B*. Front view (reduced) to show attachment of runners and horses.

windy nights, for example. In general, poisoning is most successful on warm, bright days; while the machine works best on cool mornings and cool, dark days.

A combination of the two methods is the ideal arrangement; using the poison bait along fences and ditches or on crops like tomatoes, beans and corn that will not stand the machine. The machine taking twenty-four feet at a sweep will cover forty acres per day and can thus take care of a large acreage very cheaply. On such crops as alfalfa, sugar beets, timothy and grain, before flowering time, it can be used without danger. By leaving two or three strips in a meadow when mowing, all the grasshoppers will gather on these and the machine will pick them up at a very rapid rate, thus saving the migration into other crops which so often occurs.

The construction of the machine is simple and the exact size and proportion relatively unimportant.[1] A box two feet square and sixteen feet long with a tight floor, the top and back of wire screen, with three strips in front to which are tacked 30-inch tin sheets two inches from the floor, is the ordinary form. The important thing is the construction of the catching device. The latest and best models have a low, false front, a narrow throat and an evenly curved apron which will carry the grasshoppers well into the box, as shown in Figure 4. The top is hinged in sections so that the hoppers can be shoveled out into sacks, dried and used as feed for chickens; thus changing a potential loss into a profitable feed.

The real value of the grasshopper machine is, however, as much in its availability on a moment's notice as in its economy of operation. Efficiency in insect control is founded upon promptness and effectiveness. Grasshoppers should never be allowed to reach the stage where they are threatening a crop, but crops will be threatened for a long time to come—yes, and destroyed, too—unless the future recommendations of entomologists take into consideration the probable availability of different treatments and provide for the possibilities of immediate application.

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PRESIDENT C. GORDON HEWITT: Is there any discussion?

MR. T. J. HEADLEE: How long has this machine been in operation?

MR. E. D. BALL: This machine has no inventor as far as I know. I found it in successful operation in Colorado in 1900 and they credited it to a man from Illinois. The machine they used had a curved front with a straight piece of tin in front of it at the bottom. This allowed the grasshoppers to slide straight down onto the bottom and jump right back out. In building the later machines the front was made double with the back curved so that the hoppers slid well back into the box. As originally built, it had trap doors along the back through which it could be emptied into a trench. Some enterprising man discovered that grasshoppers were good chicken feed. We then made the machines with the trap doors along the top from which the grasshoppers were shoveled into sacks.

MR. T. J. HEADLEE: Then you sack them up alive?

MR. E. D. BALL: Yes, sir. We use nothing at all. That is the beauty of the machine—easy to build, and costs nothing to operate. I have seen two small boys—in most places in Utah they have plenty of small boys—go out in the early morning and sack up forty bushels of grasshoppers in a few hours.

[1] Details of construction are given in Bulletin 138 of the Utah Agricultural Experiment Station.

PRESIDENT C. GORDON HEWITT: I will now call on Mr. Kelly to read his paper.

## THE TOXOPTERA OUTBREAK IN 1916

By E. O. G. KELLY, *Bureau of Entomology, Wellington, Kan.*

(Withdrawn for publication elsewhere)

PRESIDENT C. GORDON HEWITT: Is there any discussion?

MR. T. J. HEADLEE: I want to ask Mr. Kelly what evidence he has that the artificial introduction of parasites has accomplished little?

MR. E. O. G. KELLY: I think the evidence was in the total destruction of all those fields into which parasites were introduced.

MR. T. J. HEADLEE: That is like the chinch bug fungus. Its artificial introduction is apparently useless. Why is it not practical to kill the green-bug with spray?

MR. E. O. G. KELLY: It might in ordinary years be all right to kill them with a spray. I indicated in my paper that Mr. McColloch arrived in Wellington on the 30th of April at which time *Toxoptera* was scarce. On the 15th of May, just fifteen days later, there were several hundred thousand acres of oats devastated in that locality, as I believe Mr. McColloch can corroborate. It would be impossible to get spraying material and machines into action to cover the territory where the pests spread so rapidly. It was just like a fire starting in a dry heap. Nothing could stop it.

MR. G. A. DEAN: It might be of interest to know that at Bedford where these parasites were taken, they occurred in enormous numbers. In one field covering a considerable area, they were present by millions, far beyond a number any one could think of introducing. Just across the road, there was a field in which *Toxoptera* had totally destroyed the greater part of the grain.

PRESIDENT C. GORDON HEWITT: I will now call for the paper by Mr. W. J. Phillips.

## REPORT ON ISOSOMA INVESTIGATIONS

BY W. J. PHILLIPS, *Entomological Assistant, Cereal and Forage Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.*

The Division of Cereal and Forage Insects of the Bureau of Entomology began to gather data on the species of *Isosoma* infesting grains and grasses in 1904. From 1904 to 1906 inclusive, collections of mature infested grain and grass stems were made in most of the states east of

the Rocky Mountains, and a large amount of material was reared from these collections. From data thus secured it became evident that in order to establish definitely the identity and economic status of a species a large amount of careful and accurate breeding under control conditions would be necessary. Little was accomplished along these lines until 1912, since which time the writer has secured a large amount of valuable data on this most interesting and difficult group. These observations throw a flood of light on the economic importance of the *Isosoma* or joint worms, and clearly indicate that *I. tritici* is one of the most important pests of wheat in the Eastern States. The average farmer often confuses it with the Hessian fly, since the writer has had farmers tell him repeatedly that Hessian fly was injuring their wheat and upon examination it proved to be *I. tritici*. If wheat is badly straw-fallen before harvest, the farmer usually attributes the damage to the fly without examination.

Successful breeding of the many species of *Isosoma* in confinement is accomplished only under the most trying difficulties. A number of different types of cages have been tried, with varying degrees of success. There are two cages that have given fairly good results, though they are by no means perfect. One (Pl. 8, figs. 1, 2 and 4) consists of a wooden frame 3 feet square by 4 feet tall, two sides of which consist of a stout sash fitted with four large panes of glass. One of these sides is a hinged door the full size of the sash. The three other sides are covered with the best grade of cheese-cloth on the inside and ¼-inch mesh galvanized iron wire on the outside, to prevent the cloth being torn. The other cage (Pl. 8, fig. 3) consists of glass cylinders 9 x 15 inches and 11 x 24 inches, respectively, with cheese-cloth cover over the top. Plants are potted in 10-inch and 12-inch flower pots and the cylinders placed over them. These cylinder cages should be shaded.

One of the greatest difficulties in breeding *Isosoma* arises from the fact that the plants must mature, and it seems very difficult to provide normal growing conditions for the plant and, at the same time, confine these tiny insects. Aphids also greatly complicate the situation and in spite of the utmost care some will gain entrance and in a short time threaten the life of the plants. Furthermore, the *Isosoma* are constantly disturbed by the aphids and do not succeed in ovipositing. With two exceptions the different species have but one generation a year, therefore, should misfortune overtake some of the cages, a whole year is lost.

There are eighteen species of *Isosoma* occurring east of the Mississippi river, seventeen of which the writer has reared in confinement from adult to adult, and has thus learned some of the main facts

concerning their life history. The other species has refused to breed. Other members of the Division have, from time to time, sent infested grass stems from various points in the Western States, from which additional species have been reared. Strange as it may seem none of the strictly western species will breed in confinement here in the East, though repeated attempts have been made to rear some of them. On the other hand, *I. tritici*, which is the most economically important species in the East, has not been found in the great wheat belt of the West. No satisfactory solution of this problem has as yet been worked out. When this is done it may offer valuable suggestions for the control of the species here in the East. There are twenty-three distinctly recognizable species known to the writer at present, occurring throughout the United States, 5 of which appear to be strictly western species, 12 strictly eastern and 6 that overlap. There are undoubtedly a large number of new species among these, but no attempt has as yet been made to describe and name them, nor will this be attempted until a critical examination has been made of all types of American species.

Quite a striking illustration of what may be a new species is one that the writer has had under observation since 1912, having reared it from wheat stubble collected in Pennsylvania, New York, Ohio and Michigan. This species has been reared only from galls in the leaf-sheath surrounding heads of wheat, and there are occasionally root-like growths from the base of the gall downward (See Pl. 9, fig. 2). The head is always empty, no grain ever developing in plants thus attacked. The late Prof. F. M. Webster has repeatedly described to the writer the root-like projections he often used to find at the base of some galls. At that time he supposed these galls to be the result of the work of *I. tritici*. In 1903 Professor Webster published a paper [1] on *Isosoma* or joint worms and illustrates injury to a wheat plant that closely resembles the work of the species in question, though he used this to illustrate the work of *I. grande*.

This new type of gall is clearly represented on the front page of Bulletin 226, published in 1911 by the Ohio Agricultural Experiment Station, although it was intended to illustrate the work of *I. tritici*. The plant is affected in an entirely different manner by *I. tritici* (Pl. 9, fig. 3), and the two species also differ both structurally and in their life-histories. *I. tritici* pupates in the fall, males occur in abundance, and the galls are always in the wall of the stem; the former species pupates in the spring, no males having occurred in three years continuous rearing, and the galls always occur in the leaf-sheath surrounding the head and there are occasionally root-like

[1] U. S. Dept. Agr. Div. Ent., Bul. 42, p. 18, Fig. 5.

growths at the base of the gall. The species has undoubtedly been present in the Eastern States for many years and entomologists simply assumed that these galls were those of *I. tritici*. This is not at all strange or unusual since anyone but those very familiar with the group may easily confuse a number of the species.

Prof. R. W. Doane describes a species from Utah that forms galls in the leaf-sheath surrounding the head of wheat, as *I. vaginicolum* n. sp.[1] Upon request Professor Doane kindly sent specimens of his species and they were received just as this paper was being prepared. They agree in every structural detail with the species that occurs here in the East. The effect upon the plant, as described by Professor Doane also agrees entirely with the injury as noted here in the Eastern States.

A number of interesting facts have come to light as a result of cage breeding with individual species. One of the most important is that, up to the present, no species can be induced to breed on any other plant than its own particular host. This fact was ascertained by making repeated efforts to rear in confinement a given species in plants other than its own host. Before this could be attempted, however, sufficient breeding had to be done to definitely establish the identity of a species. It seems now to be a definitely established fact that the three species occurring in wheat cannot be induced to breed in any other plant. The same is true of those occurring in rye and barley, and on down the list. This is a very important economic fact, since it simplifies greatly measures for control.

Elymus species is by far the most favored host with *Isosoma*, from which no less than seven species have been reared. Wheat and Agropyron sp. come next with three species each; rye and blue-grass (*Poa pratensis*) follow with two each; barley, timothy (*Phleum pratense*), orchard grass (*Dactylis glomerata*), *Poa* sp., *Festuca* sp., and *Bromus* sp., have a species of *Isosoma* common to each.

The list just mentioned contains new species and may not and very probably does not include all species that have been previously described from this country. Some species that were very common years ago are almost extinct today, as seems to be the case with *I. hordei*. This species was evidently very numerous and destructive many years ago in the barley growing sections of the East, and today it has almost or quite entirely disappeared from these localities. This seems to be directly traceable to the greatly decreased acreage of barley over a large part of this territory. This is also probably true for the species occurring in rye. Whenever a certain grain crop ceases to be grown consecutively in contiguous fields, the future of the species

[1] Jour. of Econ. Ent., vol. IX, No. 4.

infesting the crop becomes seriously threatened. Heretofore it has been generally accepted as a fact that the different species of *Isosoma* infesting the small grains could and did infest the wild grasses. All evidence now shows that if a species of *Isosoma* is to maintain its existence, it must be supplied continually with its own particular host. Therefore, when planning control measures in the future for a particular grain-infesting *Isosoma*, we do not need to concern ourselves about the presence or absence of any other grain or grass crop or any of the wild grasses.

Oviposition of *Isosoma* is an interesting operation from many points of view. In the first place, the position the insect assumes in relation to the stem at the time of oviposition clearly indicates whether it is a gall-forming species or one that inhabits the center of the stem. The gall-forming species always takes a position facing downward (See Pl. 9, figs. 5 and 6) while those inhabiting the center of the stem always face upward when ovipositing. *I. tritici*, a gall-forming species, inserts its ovipositor almost parallel to the long axis of the plant stem instead of perpendicular as would appear from external observations. Three to five minutes are required to deposit one egg by this species. The ovipositor is then almost withdrawn and reinserted in a different channel. This performance may be repeated until seven or eight eggs have been deposited without the ovipositor ever having been entirely withdrawn from the original point of entrance, and the entire operation may require as long as thirty to forty minutes, or even longer. The individual may then proceed to the opposite side of the stem and insert several more eggs. Occasionally there may be two individuals ovipositing within a quarter of an inch of each other. As compared with the gall-forming species, *I. grande*, form *grande*, a species occupying the center of the stem, inserts its ovipositor almost at right angles to the stem, the egg often being placed within the cavity. This species requires three to six minutes to complete oviposition, then withdraws her ovipositor entirely and usually goes to another internode. *Grande*, however, does not insert more than one egg at a point, but occasionally two may be inserted in the same internode about a quarter of an inch apart, in which case one larva proceeds to destroy the other.

*Isosoma tritici*, when ovipositing, forces the ovipositor between the fibrovascular bundles, and the egg, which has a long petiole and a very flexible chorion, is then forced through the ovipositor in the form of a long thread. As soon as the point of the egg reaches the enlarged cavity made by the ovipositor its contents flow to that point and the egg soon begins to assume more nearly its normal shape. The petiole is then apparently gradually forced in, as the ovipositor is

slowly withdrawn, since the petiole is never found lying straight but is folded back upon itself at the end of the egg, the egg finally resting with petiole down the stem but entirely within the plant tissues. The entire egg is more slender and the petiole is much longer after oviposition. Stems have been dissected, after previously killing the female in the act of oviposition, and the position of the egg noted in relation to the ovipositor. *I. tritici* eggs require ten days to hatch, though the period of incubation varies with the temperature, cool weather retarding hatching. The larvæ molt at least three times and probably four. This can be ascertained by noting the change of shape of the larva, the development of the mouthparts and the number of cast skins, or molts. As many as three cast skins have been found in a single cell with an immature larva. The gall begins to form before the egg hatches and greatly disarranges the position of the fibrovascular bundles, which undoubtedly explains why the stems fall. From the time the larvæ are hatched until they are about two-thirds grown the tissues at the point where the galls occur and immediately above and below, are very juicy and softer than at other points along the stem and remain so until the larvæ are about grown, when the galls become much harder and very woody. As the fibrovascular bundles are badly disarranged by the galls, the stem does not have the rigidity at this point it otherwise would have if no galls were present. The plants soon become topheavy, especially if the galls are in the basal joints, and will lodge or fall with the first wind or rain. The stems usually bend over immediately above the gall, since the galls are just above a joint and the stem is slightly more rigid at that point. These galls interfere seriously with the flow of sap and a large amount is undoubtedly intercepted and used as nourishment by the larvæ, thus impoverishing the kernels of wheat.

*I. tritici* larvæ require approximately three weeks to reach maturity after hatching, or a month from oviposition, the time depending largely upon the temperature. *I. grande*, form *grande*, larvæ reach maturity in less time, since they emerge later and the weather is warmer.

Twelve species have been tested and all will breed parthenogenetically; eight are normally so, producing females continuously, males rarely occurring. In fact, one species has been reared continuously through a period of three years and no males have appeared. Apparently the males are not highly thought of among the eight species just mentioned since the females never pay the slightest attention to them when they do happen to be present. The other four species are not ordinarily parthenogenetic but will reproduce in this manner, the resulting offspring always becoming males. It is very probable that all our species, could they be tested, would prove to be parthenogenetic.

Although the different species of *Isosoma* refuse to accept a substitute for their own particular host their parasites are not so conservative, several of the more important ones being very cosmopolitan in their tastes. Thus it will be seen that the majority of the *Isosoma* are of either direct or indirect economic importance, since a parasite can much more easily maintain itself where there are a number of convenient hosts available.

A long list of parasites have been reared from *Isosoma*, the majority of which are new. The life histories of only a few of these parasites have been worked out in any detail. One of the most interesting ones thus far encountered is *Eurytoma pater* n. sp. The larva is a true parasite in its early stages, the final stage being completed on plant tissue. The parasite pierces the small tender gall and places its egg on the *Isosoma* larva. When the egg hatches the host larva is about a fourth to a third grown. By the time the parasite consumes the *Isosoma* larva it is scarcely a third grown and the only alternative is for it to finish its development on plant tissue, which at that time is very soft and succulent. These larvæ do complete their development in the same *Isosoma* cell, since they seem incapable of migrating to nearby cells to prey upon other larvæ. Therefore, as stated previously, it seems that they must and do complete their development on plant tissue.

The most important parasites of *I. tritici* are undoubtedly *Ditropinotus aureoviridis* Cwfd. and *Homoporus chalcidophagus* Walsh. There are two others, *Eurytoma pater* n. sp. and *Eurytoma bolteri* Riley var. *parva* n. var., are probably next in importance. Immense numbers of *I. tritici* are killed nearly every winter by extreme cold. Another active agency in the control of *I. tritici* is a tiny mite, *Pedi-*

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PLATE 8

Fig. 1. Isosoma breeding cage with door closed.
Fig. 2. Isosoma breeding cage with door open.
Fig. 3. Pot cage for Isosoma breeding.
Fig. 4. Isosoma breeding Experiments at Charlottesville, Va.

PLATE 9

Fig. 1. Sheath dissected from the head of wheat, showing the galls in the sheath and not in the stem.
Fig. 2. Shows typical galls of the species that forms galls in the sheath surrounding the heads of wheat.
Fig. 3. Typical galls of *Isosoma tritici* in wheat. Note that the galls are in the stem itself.
Fig. 4. Plants showing typical injury from the species that forms galls in the sheath surrounding the head.
Fig. 5. A gall-forming *Isosoma* inserting ovipositor.
Fig. 6. A gall-forming *Isosoma* ovipositing.

*culoides ventricosus* Newport. Indeed, if it were not for the natural agencies of control the farmer would be either obliged to abandon wheat growing in the states east of the Mississippi River or adopt drastic measures of control.

One of the most promising measures of control of *I. tritici* at present in some of the Eastern States is to plow under wheat stubble as soon after harvest as is possible, prepare a fine seed bed and sow the clover and grass in August or September instead of seeding in the wheat in the spring. The writer does not have sufficient data as yet on this point to make a definite statement but it seems very promising. Liberal applications of commercial fertilizer or well-rotted barnyard manure will enable the plants to largely overcome the injury.

There seems to be little hope for beneficial results from burning the stubble. This was attempted for two winters in Indiana and at no time, when the ground was frozen, could the stubble be burned.

The writer hopes to have the opportunity this winter of making a thorough examination of the types of the various American species and will then describe any new species he may have, after which he will gladly identify *Isosoma* for anyone for the privilege of using the data and retaining any uniques or a small series of any that may belong to a new species.

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PRESIDENT C. GORDON HEWITT: If there is no discussion, we will proceed to the next paper by Mr. G. A. Dean.

## RESULTS OF TEN YEARS OF EXPERIMENTAL WHEAT SOWING TO ESCAPE THE HESSIAN FLY[1]

By GEO. A. DEAN, *Entomologist of the Kansas State Agricultural College and Experiment Station*

The time that wheat should be sown to escape the fall brood of the Hessian fly and the time that it should be sown to produce the maximum yield are problems that have been and are still receiving much attention from nearly every student of these subjects. In a state like Kansas, producing an enormous wheat crop, that may equal one fifth of the production in the United States, as in 1914, and in a state

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 23. This paper embodies the results of some of the investigations in the prosecution of project No. 8, Kansas Agricultural Experiment Station. The writer desires to acknowledge the valuable assistance of J. W. McColloch, assistant entomologist, for much of the work and the careful supervision of the field experiments. He also desires to express his appreciation of the valuable services of Prof. C. E. Call and members of his staff in the Department of Agronomy.

suffering heavy losses from the Hessian fly that may reach sixteen million dollars, as in 1915, the time of seeding to produce the maximum yield and the time of seeding to escape the fly are two of the most important factors in growing wheat.

"There can be no doubt that the seasonal periodicity so characteristic of animals and plants generally is exhibited in both the Hessian fly and its host plants—that there is a period of time in the fall during which, under normal conditions of food supply, the emerging flies have the best possible opportunity to perpetuate their kind and that there is likewise a period during which wheat placed in the soil stands the best chance to produce the maximum yield. This period may be designated as the normal time of fall-brood fly emergence and the normal

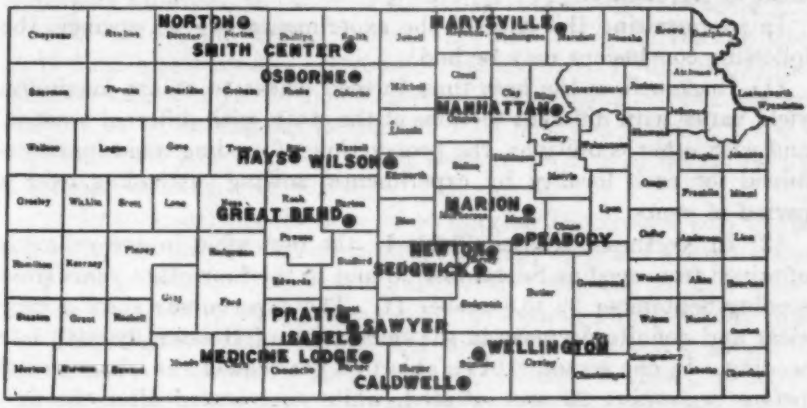


Fig. 5. Map of the state of Kansas showing stations of the last ten years.

time for wheat sowing, respectively. The problem of determining when wheat should be sown to escape the fall brood of the Hessian fly involves the explanation of the relationship existing between the normal period of fly emergence and the normal period of wheat sowing." [1]

In order to secure data bearing on the problem, a series of experimental sowing was begun in 1907 by Dr. T. J. Headlee, then entomologist of the Kansas Experiment Station. These sowings have now extended over a period of ten years, and it is planned to continue them over another period of ten years. The sowing in 1907 consisted of a single series of stations extending along the eastern edge of the wheat belt from the northern to the southern part of Kansas, but all subsequent sowings consisted of a double series of stations, one along the eastern and one along the western edge of the great central wheat belt. The individual stations of the eastern series are located from

[1] Headlee, T. J., Journ. Econ. Ent., p. 98, vol. V, No. 2, 1912.

north to south at Marysvi le, Manhattan, Marion, Peabody, Newton, Sedgwick, Wellington, and Caldwell (Fig. 5) The individual stations of the western series are located from north to south at Norton, Smith Center, Osborne, Hays, Wilson, Pratt, Sawyer, Isabel, and Medicine Lodge. Each sowing consisted of seeding a series of plots at weekly intervals for six or seven weeks, beginning the second week in September. The stations have been secured and managed coöperatively by the departments of Agronomy and Entomology of the Kansas Experiment Station. Representatives of the United States Bureau of Entomology have visited most of the stations each year, taking such data as they desired. In all cases, the ground was prepared, the seed selected and planted, and the crop harvested under the directions of the Department of Agronomy.

In summarizing the data of the experimental wheat sowings, the following conclusions may be had:

(1) Inasmuch as the best time to seed wheat to secure maximum yield varies with different sections of the state, with different seasons, and with other conditions, the proper time of seeding must be determined for each locality by experimental sowing extending over a period of years.

(2) In Northeast Kansas (Table I), the best yield in one year was obtained from seeding September 23 and in the four other years from seeding September 29 to October 11. The experiments show a very clear and definite decrease in the infestation of Hessian fly with late seeding. In one season (1914), about 50 per cent of the wheat sowed before September 20 was infested, while none sowed after the first week in October had any flies.

(3) At Manhattan (Table II), in practically all seasons, the best yields were obtained from seeding during either the fourth week in September or the first week in October. Even in several of the years when very little Hessian fly was present, there was no advantage from early seeding. This is especially true if the ground is well prepared.

(4) In East Central Kansas (Table III), the best yields have been obtained with seeding between September 29 and October 20. In the years of 1914–15 and 1915–16, the wheat sowed early was practically a total loss because of fly.

(5) In Southeast Kansas (Table IV), the sowings seem to favor rather early seeding, that is, from September 15 to September 23, as shown by the results obtained in 1913 and 1914. However, the Hessian fly caused practically no damage in these two seasons. In the seasons of 1914–15 and 1915–16, all plots sowed before October 1 were practically destroyed by the fly, and the late sown wheat produced very small yields because the fly which infested the early plots mi-

grated in the spring into the late sown plots and deposited their eggs in large numbers.

(6) In North Central Kansas (Table V), somewhat earlier seeding than for points east and south is desirable. This is because the elevation and latitude shorten the season and grain must be sowed earlier to get a good start before winter. However, the sowing tests show that, if Hessian fly is abundant, the seeding should be delayed until the second week in October.

(7) In West Central Kansas (Table VI), the best yields have been secured from September seedings. Probably the best date for this section, on the average, is from September 15 to September 20. However, as in other sections of the state, if the Hessian fly is present in damaging numbers, the seeding should be delayed until October 1.

(8) In Pratt and Barber Counties (Table VII), the seeding tests show that where no flies are present, seeding earlier than September 15 gives no better yields than somewhat later seeding. When flies are present, later seeding, up to October 1 on poor soil and October 6–7 on fertile soil and a well-prepared seed-bed, will give better results than early seeding.

(9) In summarizing the time of seeding for the greater part of the wheat belt, it may be said that on an average seed-bed when Hessian fly is not present in damaging numbers, the maximum yield of wheat will be obtained in an average season by seeding a little earlier than the fly-free date (Table VIII). The better the seed-bed is prepared, the safer it is to wait until the fly-free date to sow. It should be understood that if the Hessian fly is present in damaging numbers and the wheat is seeded earlier than the fly-free date, there is a greater risk of the crop being injured by the fly and, therefore, seeding should be delayed to as near the fly-free date as is practical.

(10) "Wheat that is sowed late usually winter-kills considerably. Since the roots do not penetrate the ground so deeply as when it is sowed early, it is more subject to injury from drought and hot winds. Late sown wheat tillers very little and hence usually gives a thin stand. It ripens later and, in the eastern part of the State, is more likely to be injured by rust than wheat that is sowed somewhat earlier. The quality of late sown wheat is usually not as good as that of early sown wheat.

(11) "If the Hessian fly is present in the neighborhood, wheat that is sowed early is practically certain to be injured by the fly and, in many instances, totally destroyed. In dry seasons, very early seeding is often detrimental because the heavy growth uses all the moisture stored in the soil and leaves the crop entirely dependent on seasonal rains. This happens frequently in the western edge of the wheat belt."[1]

[1] Bul. 213, Kansas Experiment Station, 1916.

(12) It has been found that early plowing of the stubble, at least five inches deep, is not only very effective in controlling the Hessian fly, but is also very successful in promoting a rapid growth of the wheat in the fall, and for this reason wheat may be sowed considerably later on ground that has been plowed early and deep than if it has been carelessly plowed. "When ground is plowed early, plant food is developed very rapidly and water is usually stored in the soil for the growth of the plant. As a result, growth is rapid, the plants tiller abundantly, and strong roots are developed before winter. Rather late seeding on a well prepared seed-bed will give much better yields than early seeding on poorly prepared ground even when no Hessian flies are present. Also, wheat that has made a good growth is better able to resist attacks of the fly, since it tillers more and there are more stalks to take the place of those destroyed." [1]

(13) Since many of the flies migrate considerable distances, early, deep plowing, to be effective, must be practised by the entire neighborhood in such a manner as to include all infested fields, and since it is usually impractical to plow all fields in a neighborhood early and deep, the only way to insure safety from the fall brood of fly is to sow after the fly-free date.

(14) Late sowing alone will protect most of the wheat in the fall from becoming infested by the fall brood of the fly, but it should be remembered that there is also a main spring brood and, if any volunteer is growing in the main field of wheat, or in the old stubble fields left to plant to some other crop the next spring, or if there is a field of early sown wheat nearby, the spring brood of flies, emerging from the infested plants about the first of April, is very apt to infest the late sown crop, and thus wheat absolutely free from fly in the fall may become dangerously infested next spring by the spring brood (Table IX). In Kansas, in the springs of 1915 and 1916, hundreds of cases of this sort were true and it will probably always be true of any year when there is a general infestation over the whole neighborhood. The Hessian flies will migrate in dangerous numbers for several miles, hence the importance of community coöperation cannot be overemphasized. One man with a field of volunteer or with a field of early sown wheat may endanger a number of wheat fields which were free from infestation in the fall.

(15) In Kansas, the important steps in the control of the Hessian fly are: (1) early, deep plowing of the stubble; (2) the proper preparation of the seed-bed; (3) destruction of all volunteer wheat; (4) delay the sowing until the fly-free date; and (5) coöperation.

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[1] Bul. 213, Kansas Experiment Station, 1916.

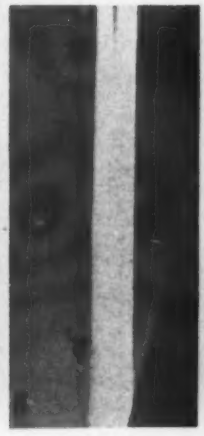

TABLE I—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN NORTHEAST KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

| | Year | Place | Date of Seeding Period | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sept. 1–5 | Sept. 6–10 | Sept. 11–15 | Sept. 16–20 | Sept. 21–25 | Sept. 26–30 | Oct. 1–5 | Oct. 6–10 | Oct. 11–15 | Oct. 16–20 | Oct. 21–25 |
| Per cent of infestation | 1907-08 | Marysville | | | | 0 | | 0 | | 0 | | 0 | |
| | 1908-09 | " | 55.4 | | 27.2 | | 54.3 | | 0 | | 0 | | |
| | 1909-10 | " | 61.0 | | 26.0 | | 1.3 | | 0 | 0 | | | |
| | 1910-11 | " | | | 3.0 | 0.8 | | 0 | 0 | 0 | | 0 | |
| | 1911-12 | " | | | 0.1 | 4.6 | 0.3 | | 0 | | 0 | | 0 |
| | 1912-13 | " | | 41.3 | | 24.4 | 4.6 | 0.7 | | 0 | 0 | | 0 |
| | 1913-14 | " | | 48.8 | 53.0 | | 42.4 | 18.0 | | 0 | 0 | 0 | |
| | 1914-15 | " | | | | | 12.0 | 10.0 | | 0 | 0 | | 0 |
| | 1915-16 | " | | | 84.2 | 50.2 | | 19.5 | 0 | | 0 | 0 | |
| | 1916-17 | " | | | | 58.0 | 82.0 | | 11.0 | 0 | | 0 | 0 |
| Bushels per acre | 1911-12 | Marysville | | | * | * | * | | 37.6 | | 25.0 | | * |
| | 1912-13 | " | | 42.2 | | 42.2 | 45.9 | 41.5 | | 39.3 | 27.8 | | 25.6 |
| | 1913-14 | " | | 22.5 | 26.4 | | 32.7 | 39.1 | | 38.4 | 23.9 | 36.1 | |
| | 1914-15 | " | | | | | 29.2 | 35.0 | | 34.2 | 29.4 | | 33.1 |
| | 1915-16 | " | | | 0 | 17.9 | | 26.9 | 26.2 | | 39.0 | 26.9 | |

* Winter killed.

TABLE II—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY AT MANHATTAN, KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

| | Year | Place | Date of Seeding Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sept. 1–5 | Sept. 6–10 | Sept. 11–15 | Sept. 16–20 | Sept. 21–25 | Sept. 26–30 | Oct. 1–5 | Oct. 6–10 | Oct. 11–15 | Oct. 16–20 |
| Per cent of infestation | 1907–08 | Manhattan | | 7.7 | | 7.3 | | 3.3 | | 0 | | 0 |
| | 1908–09 | " | | 2.3 | 1.0 | 1.8 | 1.7 | 1.4 | 0.6 | 0 | 0 | 0 |
| | 1909–10 | " | | 0 | | 0 | | 0 | | 0 | | 0 |
| | 1910–11 | " | | | 0 | 0 | | 0 | 0 | 0 | | 0 |
| | 1911–12 | " | | | 2.0 | 3.5 | | 0 | 0 | 0 | | 0 |
| | 1912–13 | " | | | | 28.7 | 12.2 | 1.8 | | 0 | 0 | 0 |
| | 1912–14 | " | | 34.1 | 31.9 | | 9.0 | 0 | | 0 | 0 | |
| | 1914–15 | " | | 57.1 | | 19.2 | 15.4 | 7.7 | 2.4 | | 1.0 | 0 |
| | 1915–16 | " | | 93.0 | 66.0 | | 69.0 | 5.0 | 1.0 | | 0 | 0 |
| | 1916–17 | " | | | 97.0 | 77.0 | | 72.0 | | 0 | 0 | 0 |
| Bushels per acre | 1907–08 | Manhattan | | 23.5 | | 26.5 | | 31.5 | | 24.4 | | 32.1 |
| | 1910–11 | " | | | 44.8 | 50.0 | | 53.8 | 52.8 | 51.2 | 45.7 | 45.0 |
| | 1911–12 | " | | | 15.0 | 26.8 | | 25.4 | 27.0 | 14.5 | | 6.6 |
| | 1912–13 | " | | | | 41.3 | 44.1 | 47.5 | | 40.3 | 25.1 | 20.0 |
| | 1913–14 | " | | 46.2 | 44.5 | | 46.5 | 46.8 | | 44.5 | 38.8 | 22.8 |
| | 1914–15 | " | | 0 | | 0 | 17.3 | 21.3 | 20.0 | | 28.7 | 22.7 |
| | 1915–16 | " | | 0 | 0 | | 0 | 16.3 | 25.9 | | 17.1 | 18.5 |

TABLE III—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN EAST CENTRAL KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

| | Year | Place | Date of Seeding Period | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sept. 1-5 | Sept. 6-10 | Sept. 11-15 | Sept. 16-20 | Sept. 21-25 | Sept. 26-30 | Oct. 1-5 | Oct. 6-10 | Oct. 11-15 | Oct. 16-20 | Oct. 21-25 |
| Per cent of infestation | 1907-08 | Sedgwick | | 23.7 | | 22.1 | | 0 | | | 0 | 0 | |
| | 1908-09 | " | 100.0 | | 100.0 | | 95.2 | | 20.3 | 0 | | 0 | 0 |
| | 1909-10 | " | | | | | 0 | 1.1 | | 0 | 0 | 0 | |
| | 1910-11 | Marion | | | 1.1 | | 0 | 0 | 0 | | 0 | 0 | 0 |
| | 1911-12 | " | | | | 0.4 | 0 | | 0 | 0 | | 0 | 0 |
| | 1912-13 | Peabody | | 4.4 | | 0 | 2.1 | 1.0 | | 0 | 0 | | |
| | 1913-14 | " | | | 40.5 | | 19.2 | 12.8 | | 0 | 0 | 0 | |
| | 1914-15 | Newton | | | | 84.0 | 66.0 | 31.0 | 16.0 | | 3.0 | 0.3 | |
| | 1915-16 | " | | | | 88.9 | | 86.2 | 30.0 | | 8.7 | 1.0 | 0 |
| | 1916-17 | " | | | | 34.1 | 37.2 | | 6.7 | 0 | | 0 | 0 |
| Bushels per acre | 1910-11 | Marion | | | 20.3 | | 20.3 | 18.9 | *20.6* | | 20.3 | 16.6 | 14.5 |
| | 1911-12 | " | | | | * | * | | * | * | | * | * |
| | 1912-13 | Peabody | | 13.7 | | 14.0 | 12.2 | *16.9* | | 9.0 | 7.0 | | |
| | 1913-14 | " | | | 24.1 | | 24.4 | *22.3* | | 14.3 | 12.7 | 11.9 | |
| | 1914-15 | Newton | | | | 1.06 | 1.0 | 1.3 | 6.0 | | 8.75 | *11.0* | |
| | 1915-16 | " | | | | 1.04 | | 1.41 | 3.33 | | 15.18 | *16.89* | 16.58 |

* Destroyed by drought and chinch bugs.

TABLE IV—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN SOUTHEAST KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

| | Year | Place | Date of Seeding Period | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sept. 1–5 | Sept. 6–10 | Sept. 11–15 | Sept. 16–20 | Sept. 21–25 | Sept. 26–30 | Oct. 1–5 | Oct. 6–10 | Oct. 11–15 | Oct. 16–20 | Oct. 21–25 |
| Per cent of infestation | 1907–08 | Caldwell | | 1.3 | | 2.4 | | 8.0 | | 5.1 | | 0 | 0 |
| | 1908–09 | " | 100.0 | | | 100.0 | 100.0 | | | | 0 | | 0 |
| | 1909–10 | " | | | 5.6 | 51.7 | 45.1 | 9.9 | 23.0 | | | | |
| | 1910–11 | Wellington | * | | | | | | | | | | |
| | 1911–12 | " | | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 |
| | 1912–13 | " | | | | 0 | 0 | 0 | | 0 | 0 | | 0 |
| | 1913–14 | " | | 1.7 | 1.2 | | 0.2 | 0 | | 0 | 0 | 0 | |
| | 1914–15 | " | | | | 100.0 | 95.0 | 35.0 | | 15.0 | | 0.05 | 0 |
| | 1915–16 | " | | | | | | 70.7 | 36.4 | | 9.5 | 2.4 | 0 |
| | 1916–17 | " | | | | 7.0 | 1.6 | | 0.4 | 1.3 | | 0 | 0 |
| Bu. per acre | 1912–13 | Wellington | | | | 8.4 | 8.6 | 6.8 | | 2.4 | 1.3 | | 0.2 |
| | 1913–14 | " | | 30.4 | 31.5 | | 30.8 | 30.7 | | 30.3 | 22.5 | 13.1 | |
| | 1914–15 | " | | | | 0.7 | 1.43 | 2.7 | | 3.7 | | 4.8 | 3.1 |
| | 1915–16 | " | | | | | | 3.5 | 5.7 | | 3.7 | 9.8 | 11.8 |

*No planting.

TABLE V—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN NORTH CENTRAL KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

| | Year | Place | Date of Seeding Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sept. 1–5 | Sept. 6–10 | Sept. 11–15 | Sept. 16–20 | Sept. 21–25 | Sept. 26–30 | Oct. 1–5 | Oct. 6–10 | Oct. 11–15 | Oct. 16–20 |
| Per cent of Infestation | 1907–08 | Norton | | | | | | | | | | |
| | 1908–09 | " | | 0 | | 0 | | 0 | | 0 | | 0 |
| | 1909–10 | " | | | | 0 | 0 | 0 | 0 | 0 | | 0 |
| | 1910–11 | Smith Center | | | 0 | 0 | | 0 | 0 | 0 | | 0 |
| | 1911–12 | " " | | | 4.0 | 0.6 | 0 | | 0 | 0.01 | | 0 |
| | 1912–13 | Osborne | | 0.5 | | 0 | 0 | 0 | | 0 | 0 | 0 |
| | 1913–14 | " | | 0.5 | 2.0 | | 0 | 0 | | 0 | 0 | 0 |
| | 1914–15 | " | | | | 0 | 0 | 0 | 0 | | 0 | 0 |
| | 1915–16 | " | | | 1.0 | 37.7 | | 51.9 | 44.0 | | 28.5 | 23.0 |
| | 1916–17 | " | | | | 41.0 | 42.0 | | 13.0 | 1.0 | 0 | 0 |
| Bushels per acre | 1911–12 | Smith Center | | | 26.8 | 26.8 | 26.8 | | 31.8 | 30.0 | | 18.8 |
| | 1912–13 | Osborne | | 44.8 | | 35.0 | 23.3 | 32.1 | | 20.8 | 27.5 | 24.9 |
| | 1913–14 | " | | 21.9 | 21.5 | | 22.7 | 19.0 | | 17.3 | 14.1 | 10.6 |
| | 1914–15 | " | | | | 30.6 | 26.7 | 29.9 | 26.3 | | 21.8 | 26.3 |
| | 1915–16 | " | | | | 15.9 | | 16.8 | 31.7 | | 29.7 | 30.9 |

TABLE VI—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN WEST CENTRAL KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

| | Year | Place | Date of Seeding Period | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sept. 1–5 | Sept. 6–10 | Sept. 11–15 | Sept. 16–20 | Sept. 21–25 | Sept. 26–30 | Oct. 1–5 | Oct. 6–10 | Oct. 11–15 | Oct. 16–20 | Oct. 21–25 |
| Per cent of infestation | 1908–09 | Wilson | | 64.0 | 58.0 | | 71.0 | 66.0 | 3.0 | | 0 | | |
| | 1909–10 | " | | | 0 | 0 | | 0 | | 0 | | | |
| | 1910–11 | " | | | 0 | 0 | | 0 | 0 | | 0 | 0 | 0 |
| | 1911–12 | " | | | 0 | 0 | 0 | | 0 | 0 | | 0 | 0 |
| | 1912–13 | " | | 0 | | 0 | 0 | 0 | | 0 | 0 | 0 | |
| | 1913–14 | " | | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 1914–15 | " | | | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 1915–16 | Hays | 8.1 | | 13.4 | | 0 | 0 | 0 | | 0 | 0 | |
| | 1916–17 | " | | 44.0 | | 7.0 | | | 2.0<br>0 | | 0 | 0 | |
| Bushels per acre | 1911–12 | Wilson | | | 20.1 | 24.9 | 27.0 | | 25.7 | 19.3 | | 8.4 | 10.3 |
| | 1912–13 | " | | 17.8 | | 13.4 | 11.7 | 10.2 | | 11.3 | 11.6 | 8.7 | |
| | 1913–14 | " | | 16.5 | 13.0 | | 20.0 | 21.0 | | 24.4 | 22.2 | 20.5 | |
| | 1914–15 | " | | | 31.9 | | 28.6 | 29.9 | 26.1 | | 18.8 | 22.2 | |
| | 1915–16 | Hays | 3.01 | | | 31.5 | | | 27.7 | | | 29.7 | |

TABLE VII—PER CENT OF PLANTS INFESTED BY THE FALL BROOD OF HESSIAN FLY IN SOUTH CENTRAL KANSAS, TOGETHER WITH YIELDS OBTAINED IN DATE OF SEEDING TESTS

| | Year | Place | Date of Seeding Period | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sept. 1–5 | Sept. 6–10 | Sept. 11–15 | Sept. 16–20 | Sept. 21–25 | Sept. 26–30 | Oct. 1–5 | Oct. 6–10 | Oct. 11–15 | Oct. 16–20 |
| Per cent of infestation | 1908–09 | Sawyer | | | | 56.0 | 100.0 | | | 0 | | |
| | 1909–10 | Pratt | | | 3.2 | | 0.5 | | 10.4 | 12.3 | | |
| | 1910–11 | " | * | | | | | | | | | |
| | 1911–12 | " | | | 0 | 0 | 0 | | 0 | 0 | | 0 |
| | 1912–13 | " | | 1.8 | | 0 | 0 | 0 | | 0 | 0 | 0 |
| | 1913–14 | Medicine Lodge | | | | | 0 | 0 | | 0 | 0 | 0 |
| | 1914–15 | " " | | | 0.6 | | 0 | 0 | 0 | | 2.2 | 0 |
| | 1915–16 | " " | * | | | | | | | | | |
| | 1916–17 | Isabel | | | | 9.5 | 6.1 | | 2.5 | 0 | | 0 |
| Bu. per acre | 1911–12 | Pratt | | | 23.3 | 21.6 | 23.3 | | 23.3 | *39.0* | | 14.4 |
| | 1912–13 | " | | 18.6 | | *35.6* | 17.8 | 18.1 | | 20.3 | 14.8 | 13.6 |
| | 1913–14 | Medicine Lodge | | | | | *31.7* | 28.6 | | 25.5 | 27.8 | 26.5 |
| | 1914–15 | " " | | | | | 19.0 | *31.7* | 18.7 | | 18.9 | 19.0 |
| | 1915–16 | " " | * | | | | | | | | | |

* No planting.

TABLE VIII—SUMMARY OF TABLES I-VII, SHOWING DATE OF MAXIMUM YIELDS AND DATE OF SAFE SOWING

| Year | Locality | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Northeast Kansas | | Manhattan, Kansas | | East Central Kansas | | Southeast Kansas | | North Central Kansas | | West Central Kansas | | South Central Kansas | |
| | Date of Max. Yield | Date of Safe Sowing | Date of Max Yield | Date of Safe Sowing | Date of Max. Yield | Date of Safe Sowing | Date of Max. Yield | Date of Safe Sowing | Date of Max. Yield | Date of Safe Sowing | Date of Max. Yield | Date of Safe Sowing | Date of Max. Yield | Date of Safe Sowing |
| 1907-08 | | No fly | Oct. 9 | Sept. 29 | | Sept. 26 | | Oct. 16 | | | | | | † |
| 1908-09 | | Oct. 5 | | Sept. 28 | | Oct. 10 | | Oct. 12 | | No fly | | Oct. 5 | | Oct. 7 |
| 1909-10 | | Sept. 22 | | No fly | | No fly | | * | | No fly | | No fly | | Oct. 18 |
| 1910-11 | | Sept. 19 | Sept. 26 | No fly | Oct. 5 | No fly | | † | | No fly | | No fly | | † |
| 1911-12 | Oct. 4 | Sept. 25 | Oct. 2 | Sept. 26 | | No fly | | No fly | Sept. 25 | Sept. 18 | Sept. 25 | No fly | Oct. 9 | No fly |
| 1912-13 | Sept. 23 | Sept. 30 | Sept. 30 | Sept. 30 | Sept. 30 | Sept. 16 | Sept. 23 | No fly | Sept. 9 | No fly | Sept. 9 | No fly | Sept. 18 | No fly |
| 1913-14 | Sept. 29 | Oct. 6 | Sept. 29 | Sept. 29 | Sept. 29 | Oct. 6 | Sept. 15 | No fly | Sept. 22 | No fly | Oct. 6 | No fly | Sept. 23 | No fly |
| 1914-15 | Sept. 30 | Oct. 7 | Oct. 12 | Sept. 28 | Oct. 19 | Oct. 13 | Oct. 17 | Oct. 17 | Sept. 27 | No fly | Sept. 14 | No fly | Sept. 27 | No fly |
| 1915-16 | Oct. 11 | Oct. 4 | Oct. 4 | Oct. 4 | Oct. 20 | Oct. 20 | Oct. 25 | Oct. 18 | Oct. 11 | * | Sept. 17 | Oct. 1 | | † |
| 1916-17 | | Oct. 9 | | Oct. 6 | | Oct. 9 | | Sept. 25 | | Oct. 9 | | Oct. 3 | | Oct. 2 |

* Planting not late enough to obtain date of safe sowing. † No planting.

TABLE IX—PER CENT OF INFESTATION OF HESSIAN FLY ON APRIL 1, 1915, BEFORE THE SPRING BROOD HAD EMERGED AND JUNE 1, 1915, AFTER THE SPRING BROOD HAD EMERGED AT WELLINGTON AND NEWTON

| Date of Inspection | Place | Date of Seeding Period | | | | | |
|---|---|---|---|---|---|---|---|
| | | Sept. 16-17 | Sept. 21-23 | Sept. 27-30 | Oct. 5-7 | Oct. 13-17 | Oct. 19-21 |
| April 1, 1915 | Wellington | 100.0 | 0.05 | 34.7 | 15.2 | 0.50 | 0 |
| June 1, 1915 | " | 100.0 | 100.00 | 100.0 | 100.0 | 100.00 | 100.000 |
| April 1, 1915 | Newton | 54.0 | 66.00 | 31.0 | 18.0 | 0.03 | 0.003 |
| June 1, 1915 | " | 97.0 | 96.00 | 97.0 | 90.0 | 80.00 | 60.000 |

PRESIDENT C. GORDON HEWITT: This paper is now open for discussion.

MR. T. J. HEADLEE: I wish to inquire of the speaker how we can harmonize the data derived from the sowings at Columbus and Wooster, Ohio, with the results he has gotton in Kansas since 1912. In five out of a possible six years at Columbus and in seven out of a possible nine years at Wooster, the date of sowing for maximum yield came later than the date of fly-free sowing.

MR. G. A. DEAN: I cannot explain this, but I believe that in order to get your fly-free date and the date for maximum yield, you must establish these local stations and carry on these experiments covering a number of years. The first two or three years in Manhattan the fly-free date was not far from the time for maximum yield. Then came the years of Hessian fly outbreaks, increasing each year. For instance, the damage in 1915 amounted to fully $16,000,000 followed next year with a net loss totaling in the neighborhood of $15,000,000 or $16,000,000. It should be remembered that in Kansas we may get five broods of the Hessian fly. For instance, we have the main fall brood, the supplementary fall brood, the main spring brood, the second spring brood, and the summer brood. In a state like Kansas, with a great variation of climate and other conditions, I don't believe you can figure out the conditions from another state, for instance, Ohio, where they do not have such a great variety of climate and conditions as we do in Kansas.

MR. A. D. HOPKINS: This subject of the Hessian fly carries me back to the West Virginia work, so that I am to be pardoned for digressing from forest insects to talk about crop insects. Ever since that work was done in West Virginia, beginning in 1887, I have continued the study of the principle or law of altitude and latitude, and in recent years the factor of longitude has been introduced, which clears up the situation and enables us to indicate dates of periodical events like

theoretical fly-free dates in Kansas from determined dates in West Virginia or Ohio. Before I came to New York to attend these meetings I attended a conference on the Hessian fly at the Bureau of Entomology and presented maps and tables showing how fly-free dates could be computed for the entire winter wheat region of the United States and Canada, and that the computed or theoretical dates agreed very closely with the general dates for sowing wheat at a number of representative places in each state, as taken from the bulletin on Seed-time and Harvest.[1] In this bulletin the dates are given on which the greater number of farmers sow wheat, which is a pretty good indication as to the best time to sow wheat to give the best yield in an average season and at the same time be late enough to escape the fall attack of the fly. The computation of fly-free dates was based on Webster's average date for Columbus, Ohio, and our present law of latitude, longitude, and altitude which may be defined as follows:

All other conditions being equal the variation in the date of a periodical event in the seasonal activities of a plant or animal in North America north of Mexico is at the average rate of four days for each 1° of latitude, 5° of longitude and 400 feet of altitude—earlier southward, westward and descending in the spring and early summer and later in the reverse directions in late summer and autumn. This gave me a fly-free date of August 31 for Orono, Maine—farthest north—and November 11 for southern Texas, a difference of seventy-two days. After determining the theoretical fly-free dates for all of the intervening states, I compared them with the general dates of sowing wheat in the same section of the states and got some rather interesting results, in showing with very few exceptions that the theoretical fly-free date coincided closely with the general wheat sowing periods for all localities compared.

At Wooster, Ohio, the fly-free date is September 20 while the average time for sowing wheat is September 18 or two days earlier than the fly-free date. At Columbus, Ohio, the determined average fly-free date is September 25, and the average date of sowing wheat is September 24.

At Wellington, Kansas, the fly-free date should be October 10. Now what is your date, Mr. Dean?

MR. G. A. DEAN: October 12 or 13.

Mr. A. D. HOPKINS: The theoretical date misses it only about a day. But October 3 is given as the best date to sow wheat. That agrees pretty well, doesn't it?

MR. G. A. DEAN: Yes, for maximum yields.

MR. A. D. HOPKINS: For Manhattan, Kansas, we have October 5

[1] Covert, James R., Seed-time and Harvest, Bul. 85, Bur. Stan., 1912.

as the fly-free date and the wheat sowing date October 28. What is your fly-free date for Manhattan?

MR. G. A. DEAN: October 4.

MR. A. D. HOPKINS: Well, there too we miss it only by a day. You cannot calculate across the country much closer. These theoretical dates will approximate the actual dates and thus serve as indices to the proper date for any place in the area in which winter wheat is sown, including Canada. The law of latitude, longitude, and altitude enables us to give an approximate date for sowing wheat anywhere from southern Canada to Texas, and we will be glad to help those of you who are investigating the Hessian fly to apply this law to your local problems. If you will give me the determined fly-free date, latitude, longitude, and altitude for any place in your state, I will explain how to find the theoretical fly-free dates for any other places in the state. Then if you will take these dates as a basis for comparison with previous or subsequent records of actual fly-free dates and let me know later on what you find it will help us both, I think. There is special need of local observations on such details. Here is an opportunity to carry out, on quite an extensive scale, investigations to determine the practical value of the law as applied to the Hessian fly.

With a known date of the disappearance of the fly at the northern range of winter wheat in Canada, we would have from four to seventy-two days in which to inform the farmers in the United States when to sow wheat at places south of the Canadian base. The actual date will vary, of course, in different localities, due to local conditions, but such constant departure will indicate the intensity of the local influence and the number of plus or minus days required to connect the theoretical date. If, on the other hand, it is a seasonal variation, as that resulting from a drought, farmers can be instructed to wait until it rains before sowing wheat.

MR. T. J. HEADLEE: How does longitude come in? I understand quite well the matter of altitude and latitude, but when you deal with longitude what is the factor? There is a principal factor that you measure, and following that, where do you establish your base line?

MR. A. D. HOPKINS: At any longitude. It makes no difference on what meridian you start. A given periodical event in the spring will be four days later 5° east and four days earlier 5° west and the reverse in the fall.

MR. T. J. HEADLEE: What is the factor you are measuring?

MR. A. D. HOPKINS: I do not attempt to explain that. I accept the facts as I find them. Specialists in other branches of science will have to explain the controlling factors. The fact that there is a variation due to longitude has been determined in Europe as well as in this

country. There the variation was found to be nine-tenths of a day to a degree of longitude. I have found that for North America it is on the average about eight-tenths of a day to a degree or four days for 5°.

MR. T. J. HEADLEE: In which direction from the base line?

MR. A. D. HOPKINS: If you begin at any point on any meridian in North America there will be a difference of about four days for each 5° of longitude, that is, any spring event, controlled by climate, will happen about four days earlier 5° west of the place and four days later 5° east of it. Isn't that clear?

MR. T. J. HEADLEE: That's clear; but it seems impossible.

MR. A. D. HOPKINS: We have conclusive proofs on this map, on which it is shown that the lines of equal phenological events, according to the law, are paralleled by the sea level isotherms, the lines of northern limits of wheat, barley and potato culture, tree growth, migration of birds, etc.

(Doctor Hopkins stated that he is preparing a paper on the subject for publication.)

PRESIDENT C. GORDON HEWITT: I will now call upon Mr. Henry Fox to read his paper.

## SUMMARY OF INVESTIGATION OF LIGYRUS RUGICEPS DeG.

By HENRY FOX, *Clarksville, Tenn.*

(Withdrawn for publication elsewhere)

PRESIDENT C. GORDON HEWITT: The paper is now open for discussion.

MR. E. N. CORY: I would like to ask Mr. Fox if he has made any survey on the eastern shore of Virginia.

MR. HENRY FOX: I have not been able to do so.

PRESIDENT C. GORDON HEWITT: I will now call upon Mr. J. W. McColloch for his paper.

## WIND AS A FACTOR IN THE DISPERSION OF THE HESSIAN FLY[1]

By JAMES W. MCCOLLOCH, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

In the course of the field experiments on the Hessian fly the writer has had his attention called to many instances of serious infestations

[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 22. This paper embodies some of the results obtained in the prosecution of project No. 8 of the Kansas Experiment Station.

in wheat fields where the possibility of fly infestation had seemed practically negligible. In some cases these were fields planted on corn land and far removed from other wheat fields. In numerous cases they were fields planted according to the best approved methods for controlling the fly. In still other cases infestations occurred where one farmer would lose most of his crop while his neighbor would suffer only slight injury. Investigations of many of these infestations suggested the possibility of some factor, such as migration, as entering into the problem of control.

## Previous References to Migration

The fact that the Hessian fly does migrate has long been recognized, but has been given little consideration and apparently has not been taken into account in devising methods of control.

Osborn (1898, *p.* 11) says, "The powers of flight possessed by the Hessian fly are sufficient to provide for its ready dispersal over limited areas, and where there are continuous or slightly separated plantings of wheat, rye, or barley, no other means of dispersal need be sought." Further on he says that there is little tendency for the adults to leave the field.

Marlett (1900, *p.* 2) writes, "The migrating and scattering brood of adults is the one developed in the fall; the spring brood does not wander much from the field in which it is developed."

Roberts, Slingerland and Stone (1901, *p.* 256) state that the migrating brood is developed in the fall and that the spring brood is less apt to scatter. They go on to say that the flies can doubtless readily fly to nearby fields and, by the aid of strong winds, they may be carried comparatively long distances.

Garman (1903, *p.* 220) says that there appears to be something like a spring migration of adults from the early sown wheat to the younger more succulent wheat of late plantings.

Headlee and Parker (1913, *p.* 135) cite a case of apparent wind diffusion covering about one-half mile and go on to state that "while the studies . . . have shown clearly that the fly sometimes does migrate this way as far as half a mile, investigations at this station and elsewhere show that spring migration in sufficient numbers to do serious damage is rare and that wheat sown on clean land late enough to escape the fall brood is practically never seriously injured."

Headlee (1915, *p.* 5) writes, "It is frequently said by a grower that there is no use to undertake fly control because some of his neighbors will fail to do their part and the fly which they fail to destroy will render his efforts useless. In some instances studies have shown that this is partly true, but the great mass of experience does not only fail

to support this idea, but clearly indicates that the individual grower usually does realize a large measure of protection regardless of the action taken by his neighbors."

## Field Observations on Migration

The writer's attention was first called to the fact that the wind might be an active factor in transporting the adult flies while studying the dissemination of chinch bugs from winter quarters in the spring of 1913. On April 20, while counting the number of chinch bugs

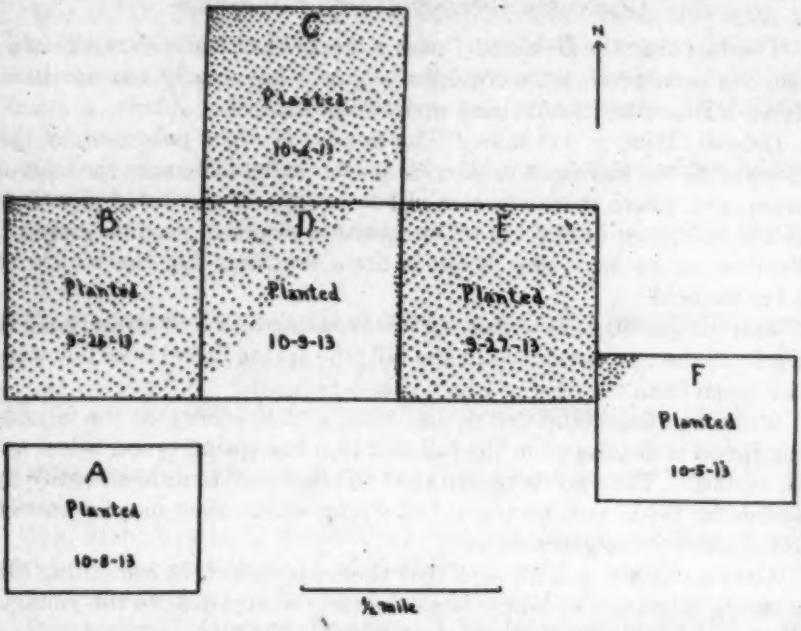


Fig. 6. Map of fields at McFarland, Kansas. Shaded area is that seriously infested at harvest.

arriving on an upright screen, a female fly was found blown against the screen. The wind was from the east at the time and the nearest infested field in that direction was over one mile away. Later on two more females were taken in the same way.

During the spring of 1914, considerable field data were collected, tending to show that the flies were being distributed by the wind. In May, 1914, the writer was requested to investigate an infestation of fly in a wheat field north of Paxico, Kansas. This field had been planted about October 10, 1913, on corn land located in the center of a large pasture. The nearest field of wheat or wheat stubble was about one

and one-fourth miles southwest. In other words, here were three conditions which would seem prohibitive to severe fly infestation, namely, late planting, new wheat land, and isolation. The writer had visited this field in December, 1913, and after a thorough investigation found no fly. On making the examination in May, 1914, it was found that 90 per cent of the plants were infested, many of them bearing as high as thirty flaxseeds and larvæ. The only apparent explanation for this heavy infestation was that the adult flies had been carried there by the wind. A badly infested field of volunteer wheat was located one and one-fourth miles directly southwest of this field, and during the period of emergence of the main spring brood of adults, the prevailing wind was from this direction.

Another example of fly diffusion due to wind is shown in Figure 6 of six fields at McFarland, Kansas. This study was made primarily to work out the value of cultural methods of control. The soil and climatic conditions are the same on all these farms and the experiment was to determine the value of the destruction of volunteer wheat and late sowing as a means of controlling the fly. On the farms A, D, and C the volunteer wheat was destroyed and the planting delayed until the fly-free date. Field F was in wheat for the first time, the preceding crop being alfalfa. On farms B and E little effort was made to destroy the volunteer wheat and planting was ten days before the fly-free date. Fields B and E were heavily damaged in the fall, while repeated search in fields A, D, C and F from November to April failed to show any appreciable fly infestation. After the emergence of the spring brood in April, however, eggs were found in large numbers over most of the shaded area. These fields were watched until harvest, at which time fields B and E were practically ruined. Field C was rather heavily infested and the northwest part of field D suffered severely. The southeast part of field D came through practically free from injury and fields A and F suffered no injury whatever. It is interesting to note that there was practically no injury along the east side of field D, although it joined one of the worst infested fields in the neighborhood. A comparison of the yields in these fields will show the true amount of Hessian fly injury.

| | | |
|---|---|---|
| Field A | | 45 bushels per acre |
| " B | | 3 to 5 bushels per acre |
| " C | | 25 bushels per acre |
| " D | NW | 25 bushels per acre |
| | SE | 40 bushels per acre |
| " E | | 4 bushels per acre |
| " F | | 45 to 48 bushels per acre |

Evidence that the wind is an important factor in the dissemination of fly is brought out in these fields. During the time the main spring

brood was on the wing, the prevailing wind was from the southwest. Field C and the northwest part of field D were in a direct line to catch any fly that might be carried from field B. A line drawn due northeast through D from the southeast corner of field B marked the extent of serious infestation in field D. The fact that the east side of field D was uninjured, together with the non-infestation of fields A and F, is a strong point in favor of wind distribution.

## Screen Experiments

In order to gather more definite data on wind dispersal of adult flies and the distance they are carried, it was planned to carry on some screen experiments about Manhattan. In order to do this it was necessary to select areas far removed from wheat fields and erect screens for catching the flies.

Two localities were chosen for this work, one for data on short distance flights, and the other for data on long distance flights. The first one was located near a small plot of wheat where migration could be studied for a range of 600 feet and the other locality was on the hills north of Manhattan where migration of from one to three miles could be studied.

At the first locality, three permanent screens were used, namely, the field insectary having a screen area of 60 square feet, located 100 feet from the infested wheat, and two smaller screens, each having an area of 6 square feet placed at 400 feet and 450 feet, respectively, from the wheat. A portable screen was used for longer distances. Table I gives the results obtained at these screens.

Table I—Showing the Number of Flies Taken in Flight at Short Distances from Wheat

| Date | Hour | Wind | | Distance from Wheat | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 100 Feet | | 400 Feet | | 450 Feet | | 600 Feet | |
| | | Vel. | Dir. | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ |
| 4-11 | 11.30 a. m. | 13 mi. | SW | 52 | 4 | | | | | | |
| | 3.00 p. m. | 21 " | " | | | 1 | | | | 2 | |
| 4-12 | 9.30 a. m. | 20 " | " | | | | | 1 | | | |
| | 4.30 p. m. | 18 " | " | | | 2 | | 2 | | | |
| 4-19 | 9.30 a. m. | 17 " | " | 1 | 1 | | | | | | |
| | 10.30 a. m. | 18 " | " | 14 | | 6 | | 6 | | | |
| | 11.30 a. m. | 19 " | " | 17 | 6 | | | | | | |
| | 4.00 p. m. | 34 " | " | | | 4 | | 7 | | | |

For studying the long distance flights, a portable screen four feet square was used. This screen was moved from place to place, efforts

being made to place it in direct line with infested fields. On April 12, the first observations were made on the hills north of Manhattan. The nearest infested field to the places where the screen was operated was a volunteer field to the southwest. Table II gives the results of this day's observations.

TABLE II—SHOWING THE NUMBER OF FLIES TAKEN IN FLIGHT AT DISTANCES RANGING FROM ONE-FOURTH TO TWO MILES FROM WHEAT ON APRIL 12, 1916

| Time | Wind | | Distance from Volunteer | No. Flies | |
|---|---|---|---|---|---|
| | Dir. | Vel. | | ♀ | ♂ |
| 10.15–10.20 | W SW | 18 mi. | ¼ mile | 1 | |
| 10.25–10.35 | " | 18 " | ½ mile | 2 | |
| 10.45–10.50 | " | 18 " | 1½ miles | 2 | |
| 11.00–11.30 | " | 13 " | 2 miles | 8 | |

On April 16, the screen was run from three to four p. m. at two miles from the volunteer wheat and one female was caught. In this case, the wind was slightly south of southwest and the female came from the volunteer wheat or else from the wheat plots on the College campus three miles away. The day was cool and partly cloudy and there was little activity of flies even in the wheat fields. The wind velocity was twenty-two miles per hour.

On April 18, the screen was placed on the Manhattan country club grounds from 10 to 11.30 a. m. and during that time one female was caught. The wind was very strong from the southwest, the velocity being from 24 to 27 miles per hour. The nearest wheat from this location was five miles southwest. From 12.30 p. m. to 2 p. m., the screen was run at two miles from the volunteer field mentioned above. During this time one female was caught. The wind velocity was 24 miles per hour. On April 19, the screen was again run at two miles from the volunteer wheat from 11 a. m. to 12.15 p. m. and five females were caught. The wind velocity was 19 miles per hour during this time.

## GENERAL NOTES

It is interesting to note that of the 146 flies taken in flight, 135 are females and that no males have been taken at a greater distance than 100 feet from wheat. As far as the writer has been able to ascertain, flies that have been carried two miles by the wind are not injured. A large number of the females taken at this distance have been placed on wheat where they began to oviposit at once. Fertilization had apparently taken place before flight, as all the eggs thus obtained were fertile.

## Economic Importance and Conclusions

The fact that fertilized females may be carried long distances by the wind has an important bearing on the control of the fly. It means that coöperation must be practiced over large areas and that the individual grower cannot be promised immunity from injury even if he does prepare a good seed-bed and plants late. It means that all stubble fields and volunteer wheat fields *must* be plowed under early in the fall as they are the greatest sources of infestation.

At the place where many of these observations were made, the flies were being carried up over the hills and into the wheat fields lying on the other side in the Blue River valley. The fact that the flies were uninjured on reaching the screen would indicate that they could be carried much greater distances. The relatively large number of flies caught on the small screen area at two miles indicates the possible magnitude of these flights.

The distribution of the fly in the State of Kansas may be influenced largely by the wind. The prevailing winds of this state are from the south and southwest and it is a noticeable fact that the spread of the fly has been slowest in a southwesterly direction.

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President C. Gordon Hewitt: Is there any discussion?

Mr. E. O. G. Kelly: I am very much interested in this paper. Several years ago, about the time I first joined the Department, in 1907, Professor Webster assigned the Hessian fly problem to me for study. Shortly after that we had an extended conference regarding the Hessian fly. He informed me that he had observed them to be very numerous and in damaging numbers in one field, and across the road there would be none. He had observed that when flies were very abundant in a field, they flew very close to the ground. I have made numbers of observations on this insect in this relation, that is, its flying habits. When the adults are out in large numbers, ovipositing on

wheat in fall or spring, they fly very closely to the plants, flying short distances along the wheat row, touching the ground and plants frequently. I have seen them so thick in the fields at times that one would imagine that they were gnats and it only required that one be caught for examination to determine that they were not gnats. During the spring of 1913, I believe it was, I decided that I wanted to determine how high the adult flies would fly. I built a large frame, covering it with boards, and set it north and south, or rather, facing the south, because the wind was blowing from that direction. Tanglefoot papers, such as are used to catch flies in the dining rooms, were tacked to the board; I was amazed to find that I got flies no higher than about seven inches from the ground. I followed that observation again the next fall with the same apparatus, making similar observations. In the fall of 1914 I built a frame and covered it with wire screen. The screens were built in an infested wheat stubble field 3 feet high and 9 feet long, placed at right angles—one to catch flies which went east and west, and one to catch those that went north and south. They were painted with very thin tanglefoot in order to catch them and hold them fast. The flies being numerous at this time, less than five minutes were required to catch a number. I then noticed they were flying over the three-foot screen. I immediately proceeded to build one twelve feet high, placing it near the low one. By use of a step-ladder I found they were flying over the 12-foot board frame. The 12-foot screen caught large numbers; the amounts I will not attempt to give you. The peculiar thing which bears out Mr. McColloch's discussion regarding the wind was that the flies were always flying in the direction of the wind. One interesting observation was made in connection with the screen placed at the west edge of the field. The wind was blowing toward the west, from the direction of the infested field, many adults being caught. In thirty minutes or less, after the screen was erected, the wind changed, coming directly from the west and those flies which had been blown into a cornfield on the other side, or west, came back, or were blown back. This gave us indications, however, that the flies were flying higher than 12 feet and we accordingly erected a screen about 14 feet wide and ran it up 30 feet. We got flies at the top of the screen.

In 1915, I continued the observations on a screen 14 feet wide and 30 feet tall, erected near wheat fields. The flies were flying 30 feet regularly, but the majority were between 19 and 21 feet, and most of them on the 21st space.

MR. T. J. HEADLEE: I should like to inquire whether the speaker or any one else here has any data to show the character of the wind that produced this flight.

MR. E. O. G. KELLY: I will answer that by saying that the winds are very light when flies are flying, and during a strong wind the adults will cling close to the plants. The records I have were made at Wellington. The days on which we caught the flies, the wind velocity was less than twenty miles per hour. If the wind is higher than that, not many flies are caught.

MR. J. W. MCCOLLOCH: The records of the station bear out what Mr. Kelly just said—twenty miles is the maximum velocity.

PRESIDENT C. GORDON HEWITT: If there is no further discussion, we will close the reading of papers for the session.

(After conducting routine business the session adjourned.)

*Afternoon Session, Saturday, December 30, 1916, 2.10 p. m.*

PRESIDENT C. GORDON HEWITT: The first paper on the program will be presented by Mr. C. W. Collins:

## METHODS USED IN DETERMINING WIND DISPERSION OF THE GIPSY MOTH AND SOME OTHER INSECTS[1]

By C. W. COLLINS, *Bureau of Entomology, U. S. Department of Agriculture*

In 1910, some experiments were begun at the Gipsy Moth Laboratory to determine if, and to what extent, gipsy moth caterpillars were carried by the wind. These had their inception in a small way by allowing the newly hatched larvæ to spin or drop into a current of air circulated by an electric fan. In this experiment the larvæ were buoyed up and could be seen floating from one room through another. These experiments were enlarged upon later in the season by using small poultry wire screens treated with tanglefoot. They were set up on a salt marsh area. Newly hatched larvæ were liberated from boxes fastened to a stake at given distances from the screen in the opposite direction the wind was blowing. Larvæ were caught on these screens at distances varying from 50 to 1,833 feet from liberation point and these were followed by larger experiments, the details of which, with other notes on dispersion of the gipsy moth, have been published by Burgess,[2] and later results by the writer.[3] Stabler[4] and his associate

[1] Published by permission of the Chief of the U. S. Bureau of Entomology. Other illustrations of methods used in dispersion experiments will be found in Bul. 273, Bur. Ent., U. S. D. A., 1915.

[2] Burgess, A. F. The Dispersion of the Gipsy Moth. Bul. 119, Bur. Ent., U. S. D. A., 1913.

[3] Collins, C. W. Dispersion of Gipsy Moth Larvæ by the Wind. Bul. 273, Bur. Ent., U. S. D. A., 1915.

[4] Stabler, H. P. Red Spiders Spread by the Wind. Mo. Bul. Cal. Hort. Com., II: 12 p. 777, 1913.

later discovered that the almond mite (*Bryobia pratensis*) was carried extensively by the wind, having taken it on sticky fly paper 650 feet from an infested orchard and on top of a schoolhouse 50 feet high. Quayle[1] has given us evidence that the young black scale (*Saisettia oleae*) is dispersed by the wind as it was taken in tanglefoot 450 feet from the nearest infested trees. This species was distributed over an entire four-acre block of trees, chiefly by the wind in a single season. The young of the red scale (*Chrysomphalus aurantii*) was also taken at distances ranging from 30 to 150 feet. Titus[2] has observed that young thrips are carried by the wind at a height of 20 feet.

Observations on time of hatching of gipsy moth eggs in comparison with development of foliage in 1916 showed that *Forsythia vulgaris*, a common shrub on lawns in eastern Massachusetts is approximately in full blossom just previous to hatching of the eggs. The garden cherry (*Prunus avium* L.) and pear (*Pyrus communis* L.) also blossom just previous to first hatching. Shad bush (*Amelanchier canadensis*) blossoms about this time. The late varieties of apple first begin putting out their leaves simultaneously with the first hatching. The buds of some of the hardwoods in the woodlands, such as the hickories and oaks begin putting out their leaves somewhat later than those of the apple and simultaneously with general hatching of the gipsy moth. Windspread of the newly hatched larvæ closely follows hatching and extends approximately over the same period, namely, from ten days to three weeks depending upon the season. During a long cold spring, development of the foliage and larvæ is much retarded; hence wind dispersion spreads over a longer period.

In order to determine the direction from which larvæ came when found upon a screen at a stated time, it was necessary to keep detailed records of the winds and temperatures during the dispersion period. The activity of the young larvæ is directly influenced by the temperature and hourly readings were taken daily during the period of windspread. A small weather vane was attached to one of the posts of the screen under observation and hourly or half-hourly readings recorded. By noting the time that each larva was found on the screen and figuring back to the previous examination, it was possible to give the approximate direction and source from which they came. A small hand anemometer was also used to record the velocity of the wind, an observation with which was taken hourly or every two hours. Use was also made of the same weather data collected by the U. S. Weather Bureau at Boston, Mass., Providence, R. I., Concord, N. H., and Portland, Me.

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[1] Quayle, H. J. Dispersion of Scale Insects by the Wind. Journ. Econ. Ent., vol. IX, No. 5, p. 486, 1916.

[2] Titus, E. G. Journ. Econ. Ent., vol. IX, No. 5, p. 492, 1916.

Locations for screen experiments were selected with reference to distance from infested woodlands and nature of surrounding vegetation; that is, finding areas where there was little favorable food for the gipsy moth, so that little scouting had to be done to determine if the eggs of the insect were already present. Marsh areas, beaches, and islands off the coast best met these requirements. A screen was thus located at Salisbury Beach and Plum Island, Mass., where large expanses of salt marsh from one to two miles wide separated the infested woodlands from the sandy beaches and ocean.

An altitude experiment with aviation of small caterpillars was conducted at Merrimac, Mass., which consisted of a screen 36 feet long and 4 feet high erected on top of the town standpipe. The latter was located on a hill and towered 55 feet above the summit, so that the screen was 300 feet above sea level. Other hills one-half mile and more distant, also the valleys were generally infested and 141 newly-hatched larvæ were taken in a season on this screen of 144 square feet. This experiment together with three large screens located on hilltops in New Hampshire gave data which assisted in explaining the source of many new infestations found during the scouting operations on hilltops in outside territory.

A location for a screen on the Isles of Shoals, N. H., was selected on Lunging Island, the most western of the group. These islands are located six miles from the nearest mainland and 13½ miles from mouth of the Merrimack River to the southwest. Living gipsy moth larvæ were removed from the screen during a continuous period when southwest winds were blowing, thus proving that they are wind borne 13½ miles or farther. After securing a total of 67 newly hatched gipsy moth larvæ on the screen at Isles of Shoals in 1914, nine of which were wind borne from a distance of 13½ miles or more, it was evident that the maximum distance had not been found. A location was then searched for where a screen could be erected an even greater distance from infestations, and this was found on the end of Cape Cod, Provincetown, Mass. Here a large poultry wire screen was erected on the sand about 75 feet from the shore and near Race Point Light.

Tanglefoot was applied and examinations were begun at the dispersion period of 1915. Winds striking the screen at this point from the south, southwest, west or northwest must pass over 19 to 35 miles of salt water from the mainland. Two to three examinations of the screen daily were made during the dispersion period in 1915.

In order to further check these data on long distance spread, the Provincetown screen which was razed during a storm in winter of 1915–16 was rebuilt in the spring of 1916. New wire of ¼-inch mesh was applied, as the old tanglefoot so darkens after one year that it is

difficult to find small objects upon it. It was made the same dimensions as the old one; namely, 75 feet long with wire 6 feet wide, totaling 450 square feet. Another type of screen was also used at Provincetown, which consisted of white cotton cloth three feet wide tacked to sides and ends of a small building located near the shore. The top selvage of the cloth was eight feet from the ground and contained 162 square feet to which tanglefoot was applied. While there were no caterpillars taken on the cloth screen in 1916 at Provincetown, similar cloth screens at Salisbury Beach, Mass., and Isles of Shoals, N. H., in 1913 and 1914 gave similar results to the wire screens.

Two men were stationed at Provincetown in 1916 and were able to make from 5 to 8½ examinations daily, thus keeping the screen clear at all times in case of sudden shifts of the wind. The details of the daily catches are given in the following table for 1915 and 1916:

TABLE SHOWING NUMBER OF *P. dispar* LARVÆ CAUGHT ON SCREEN, PROVINCETOWN, MASS., 1915 AND 1916, WITH DIRECTION AND DISTANCE FROM WHICH THEY CAME

| Date of Catches | Scituate and Cohasset to Duxbury, Mass. W to NW, 21–30 miles | Plymouth to Orleans, Mass. SW to SSE, 19–22 miles | Wellfleet to Truro, Mass. SE, 9–12 miles | Provincetown, Mass. E and NE, 1½–2 miles |
|---|---|---|---|---|
| 1915 | | | | |
| May 16 | —— | —— | —— | 51 newly-hatched |
| 17 | —— | —— | —— | 7 " " |
| 18 | —— | —— | —— | 16 " " |
| 19 | 7 newly-hatched | —— | —— | —— |
| 20 | —— | 9 newly-hatched | —— | —— |
| 21 | —— | —— | —— | 24 newly-hatched |
| 22 | —— | 5 newly-hatched | —— | —— |
| 24 | —— | 2 " " | 5 newly-hatched | —— |
| 25 | —— | —— | —— | 2 newly-hatched |
| Total 1915 | 7 newly-hatched | 16 newly-hatched larvæ | 5 newly-hatched | 100 newly-hatched |
| 1916 | | | | |
| May 19 | —— | 1 newly-hatched | —— | —— |
| 22 | —— | 2 " " | —— | —— |
| 25 | —— | 2 " " | —— | —— |
| 26 | 12 newly-hatched | —— | —— | —— |
| 29 | —— | —— | 3 newly-hatched | 4 newly-hatched |
| June 1 | 1 newly-hatched | —— | —— | 1 " " |
| 2 | 1 " " | —— | —— | —— |
| Total 1916 | 14 newly-hatched larvæ | 5 newly-hatched | 3 newly-hatched | 5 newly-hatched |

Grand Total for 1915—128 larvæ
Grand Total for 1916— 27 larvæ

From the foregoing table it will be noted that 23 larvæ out of a total of 128 were borne by winds from the westward and south in 1915 and 19 out of a total of 27 in 1916 from the same directions. The

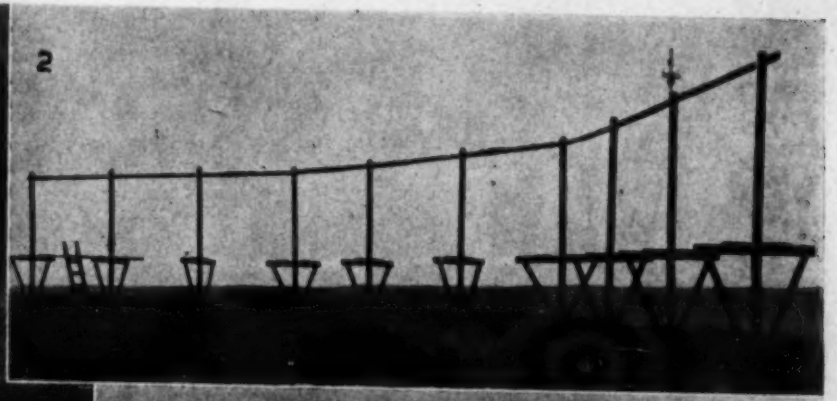
shortest distance from lower Cape Cod or the mainland in these directions is about 19 to 22 miles. Some of these larvæ which were borne onto the screen by northwest winds came from a source even more distant, namely, 21 to 30 miles. A total of 8 larvæ came from the southeast during the two years—a distance of 9 to 12 miles or more—and 105 from infestations to the eastward of the screen in Provincetown. The data collected at this screen give new records on wind dispersion of 20 to 25 miles or more and have great bearing on the proper control measures to practice in preventing spread of the insect.

The methods used to prevent spread of the gipsy moth by the Bureau of Entomology in former years were to do as much work as possible in the heavily infested area, consisting of roadside thinning, spraying and treating of egg clusters, so as to keep down such infestations and prevent larvæ being carried on vehicles and automobiles. After 1912, when the theory of windspread of the newly-hatched larvæ was proved and accepted, the base of control measures was moved adjacent to the border, especially the western, where there was greatest danger of spread eventually to central and southern United States. A strip of territory about 25 miles wide is carefully worked each year. All old infestations are cared for in this area, and when new infestations are found, creosote is applied to all egg-clusters and in many cases is followed by spraying. Tanglefoot bands are applied to trees, where the infestation is at all heavy, to prevent the small larvæ hatching on or near the ground, ascending the trees and being blown long distances by the wind.

Better results can be seen in preventing spread of the insect since the latter course was taken, as the increased territory each year since 1912 has not been so great in proportion to that previously infested.

Mr. C. W. Minott, of the Bureau of Entomology, conducted some interesting investigations during May and June, 1916, with reference to windspread of gipsy moth larvæ on cranberry bogs. The woodlands of the Cape Cod section of Massachusetts where cranberries are extensively grown, have become badly infested in some towns, and the larvæ have spread onto the bogs, thus causing trouble and alarm to the growers. In many instances, vines on the bogs have been heavily fed upon and even stripped of their foliage. The growers have met these conditions by spraying and clearing around the borders to prevent, as much as possible, the large larvæ crawling in.

Two bogs were selected for experiments on wind dispersion in Carver, Mass., namely, Muddy Pond Bog, containing about one hundred acres and Johns' Pond bog containing about forty-four acres (including pond). Six screens made of cotton cloth tacked to a frame in two sections, each being 3 by 10 feet, were set up horizontally near the vines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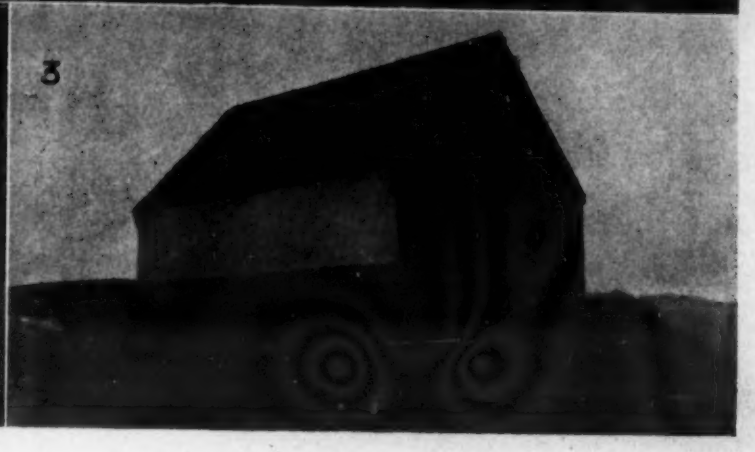
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at various distances from the woodlands. Each screen contained 60 square feet of cloth upon which tanglefoot was applied. Daily examinations were made of each screen and data also taken on the temperature, direction and velocity of the wind during the dispersion period.

The screens were located on the bogs at various distances ranging from 400 to 1,200 feet from woodland infestations. From one screen located 600 feet from infested woodland on the northwest and 900 feet on the west, there were removed 62 small larvæ during the season, or slightly more than one to the square foot. A total of 143 small larvæ was wind borne onto the six screens, which indicated that an average of about 17,000 were blowing on to the bogs per acre. The infestations around these bogs, to date, are only medium in extent, which indicates what happens on bogs bordered by heavily infested woodlands and what the conditions will be here as the surrounding infestations increase. Concerted action is needed to prevent further increase of the gipsy moth in towns where cranberries are the main crop.

In connection with the wind dispersion experiments of the gipsy moth, data were secured on some other lepidopterous species. June 1, 1914, Mr. C. E. Hood removed from the screen at Plum Island, Mass., a living first stage larva of *Hemerocampa leucostigma* S & A. Between the period the larva was found and the previous examination of the screen, the wind blew from the southwest at a velocity of from four to five miles per hour. The nearest tree growth was some willows, two-thirds of a mile distant, across the salt marsh, and it is evident that the larva came from this source.

Some other lepidopterous larvæ were taken on screens located on the hills of New Hampshire in 1913 and 1914. These screens were located 200 to 500 feet from tree growth. One specimen taken in Hillsborough, N. H., where the nearest trees were fully 500 feet distant, was either *Hemerocampa leucostigma* S & A or *Notolophus antiqua* L. The specimen taken on the screen was so badly injured after having been removed from tanglefoot that a more accurate determination could not be made. Both the above species of larvæ are thickly clothed with very long acuminate hairs, but are not provided with hairs bearing swellings or vesicles. It was thought by Wachtl and Kornauth[1] that the latter hairs with balloon-shaped swellings made the caterpillars buoyant in the air, but more recent investigations tend to militate against that theory.

Nine specimens of a species of *Noctuidæ* were also taken on the screens. These larvæ are yellowish-white with brown chitinous plates

[1] 1893 Wachtl und Kornauth. Beiträge der Kenntniss der Morphologie, Biologie und Pathologie der Nonne (*Psilura monacha*). In Mittheilungen aus dem forstlichen Versuchswesen Osterreichs, V. 16, 38 p., 3 pls., 8 figs.

on dorsum and laterad. The plates each bear spinules. Head and legs brown. The other species under consideration is a *Geometrid*, two small specimens being taken. They are grayish brown in color and practically nude of hairs. Specimens of the latter two species were submitted to Mr. August Busck of the U. S. National Museum for determination. All these larvæ were taken in tanglefoot in situations distant from the posts, where they could not possibly have crawled. The screens on which the latter, or practically hairless, larvæ were taken were located quite near tree growth—200 to 500 feet. The recording of three and possibly four species of lepidopterous larvæ other than the gipsy moth (*Porthetria dispar* L.) and the nun moth (*Psilura monacha*) being carried by the wind adds to the probability that there are many other species dispersed in this way.

## Summary

Additional data have been collected on long distance wind dispersion of gipsy moth larvæ; namely, across Cape Cod Bay off the coast of Massachusetts. The direction of the wind recorded at the time taken and previously, indicated the source of infestation to be 19 to 30 miles distant on the mainland. Frequent examinations of the screens and close data kept on movements and direction of the winds were necessary to make these records of value.

Screens used in the cranberry bog experiments and placed horizontally over the vines were well adapted to catch the drop of small larvæ floating over such areas while the upright wire and cloth screens proved better for securing long distance spread.

The recording of three extra lepidopterous species and possibly a fourth being carried by the wind in the larval stage suggests some possibilities for investigation with others along this line.

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President C. Gordon Hewitt: The paper is now open for discussion.

Mr. A. F. Burgess: Some may wonder why the *Geometrid* and

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Plate 10

Fig. 1. Thermometer, weather vane and anemometer used in recording weather data in connection with Dispersion Experiments. Fig. 2. Wire screen at Provincetown, Mass., upon which small gipsy moth larvæ were taken, having been wind-borne about twenty-five miles. Fig. 3. Upright cloth screen; a type used in Dispersion Experiments, Provincetown, Mass.

Plate 11

Cranberry bog showing horizontal cloth screen to catch drop of wind-borne gipsy moth larvæ. Tanglefoot had not been applied to screen.

*Noctuid* larvæ were not more definitely determined. These caterpillars are very small, being in the first stage and after having had a tanglefoot bath, it was impossible to determine them more definitely.

MR. J. W. McCOLLOCH: What size of mesh was used in the screens.

MR. C. W. COLLINS: We used ¼-inch mesh, also ⅛-inch, but did not use the two sizes under exactly the same conditions.

MR. J. W. McCOLLOCH: Is this cloth wire or poultry wire?

MR. C. W. COLLINS: Poultry wire.

MR. E. D. BALL: This paper opens up a very definite field for work. An observation I made this winter leads me to believe that I found San José scale infestation which had been wind borne three or four blocks, and that a single infested tree had apparently been the source of the infestation. I wonder if any of this work has been done on scale insects.

MR. C. W. COLLINS: We have not done any. Professor Quayle has carried on some interesting experiments on black scale in California. He succeeded in taking them 450 feet from infested orchards and he has taken red scale 150 feet from an infestation.

PRESIDENT C. GORDON HEWITT: I will now call on Mr. Crossman to present his paper.

## SOME METHODS OF COLONIZING IMPORTED PARASITES AND DETERMINING THEIR INCREASE AND SPREAD

By S. S. CROSSMAN, *Entomological Assistant, Bureau of Entomology, U. S. D. A.*

The control of phytophagous insects by means of entomophagous ones may be divided into two classes: first, the control of native insects by native parasites; second, the control by importations of parasites and predaceous enemies of injurious insects which have become established in a new land. In the United States at least one half of the injurious insects of economic importance are of exotic origin and have become established in this country, because they are unhampered by many of the factors that hold them in check in their native lands. Dr. C. V. Riley, while entomologist to the United States Department of Agriculture, was the first to introduce successfully into this country a parasite of an insect of exotic origin. In 1883[1] he succeeded in establishing *Apanteles glomeratus* L. which is a parasite of *Pontia rapæ* L. Six years later *Novius cardinalis* was introduced into California.

Since Riley's successful introduction of *A. glomeratus*, many importations of beneficial insects have been made and the future undoubtedly

[1] Popular Science Monthly, vol. LXXII, pp. 363, April, 1908.

holds great opportunities for such work. With this in view it was suggested by Mr. A. F. Burgess that a paper dealing with some of the methods that are being used for colonizing imported parasites and checking their status in their new environment would prove of interest and value to others who are working with similar projects.

The methods used in introducing and establishing a new insect depend entirely upon its habits, life cycle, and seasonal history. In the time allotted for this paper, it would be difficult to deal in detail with the many parasites which are receiving attention at the Gipsy Moth Laboratory. Accordingly, I shall discuss the methods used in handling only two species, namely, *Anastatus bifasciatus* Fonsc. and *Schedius kuvanæ* How. These insects belong to the family *Encyrtidæ* and parasitize the eggs of the gipsy moth; otherwise they have little in common.

The story of the importations and successful establishment in America of these parasites is a fascinating one and has been reported by Howard and Fiske in Bulletin 91 of the Bureau of Entomology. Both were successfully colonized during the summer of 1909, *Anastatus* being liberated as larvæ within imported gipsy moth eggs, while *Schedius* were released as adults, which were obtained by breeding at the laboratory.

It is essential that the life and seasonal histories of the host and parasite be known before work of this nature can be done intelligently. The seasonal histories of the parasites with which we are dealing are briefly as follows: *Schedius* hibernates as an adult. In the spring, a week or two before the gipsy moth eggs hatch, these hibernated individuals may be found ovipositing in gipsy moth eggs, starting a spring generation, the progeny of which carries the species through the summer. In July soon after the gipsy moth eggs are laid, *Schedius* attacks them and a generation is produced about every twenty-five days, until cold weather sends them to their hibernating quarters. Four generations and a partial fifth are completed each fall by *Schedius*. *Anastatus*, on the other hand, like its host, has but a single generation. Very soon after the gipsy moth lays her eggs, *Anastatus* oviposits in them and the larva of the parasite devours the egg contents before the embryo has time to develop. It remains within the host egg through the winter and early summer, until a week or so before the gipsy moth eggs are laid, and after pupating the adult parasite issues and attacks the new eggs. It is important to note that these parasites do not disperse at an equal rate, *Anastatus* spreading much slower than *Schedius*. Also that *Anastatus* has but one generation each year, while *Schedius* has several generations. These facts have an important bearing on the plans of work.

Material for colonizing *Schedius* is obtained by breeding at the laboratory. The trays used for this work are 5 feet long, 2½ feet wide, and 3 inches deep. They are lined with black paper and covered with white cotton cloth. Two holes twelve inches square are cut in the top, each half way between the center and end of the tray, through which the *Schedius* are fed. Sheets of glass are placed over each hole to prevent the adults from escaping. During the middle of August, about 25,000 gipsy moth egg clusters are collected from any convenient locality to be used in the breeding trays. These are then slightly broken and spread evenly over the bottom of each tray. About the same time a few hundred egg clusters are collected from some locality where *Schedius* is present and placed in glass vials, 8 inches by 2 inches, which are examined daily. Soon adult *Schedius* of the first fall brood issue and are transferred from the vials to the breeding trays, where they have an abundance of gipsy moth eggs for oviposition. In this manner each breeding tray is stocked with from 3,000 to 5,000 *Schedius*. Strips of banana peel sprinkled with sugar are placed in the trays for food for the *Schedius*. It is quite important that the breeding trays be kept in a warm room, else the parasites do not oviposit freely. The breeding trays are started at intervals over a period of two to three weeks, so that the parasites issue continuously from the eggs in the trays during the colonizing period, which extends from the last of September to the middle of November. In about twenty-five days a new generation of *Schedius* will be found issuing from the eggs in the breeding trays. Just previous to the issuing period, the trays are darkened by placing black paper over the glass in the tops and a series of one-inch holes are bored through the side, into which are inserted paper cones which hold glass tubes. Electric lights are now placed in front of the tubes and after a number of *Schedius* have entered a tube, it is replaced by an empty one. An estimate is made of the number of *Schedius* in this tube; then by gently tapping it, the *Schedius* drop into an eight-inch mailing tube. About 1,600 parasites are placed in each mailing tube, and honey and water smeared on a piece of paper is enclosed for food. These parasites are now ready for colonization and the tubes are either mailed to men in the field or taken by them for immediate liberation.

Material for colonization of *Anastatus* is obtained from collections made in the field. Large collections of gipsy moth egg clusters are made from heavily infested territory, where the percentage of parasitism is high. The following method is used: There is a strong colony of *Anastatus* in a town not far from the Melrose Highlands laboratory. The exact location where the colony was liberated is taken as the center and lines are run in eight directions: N, NE, E, SE, etc. Ten egg clusters are collected at the center and at points every hundred

yards along these lines. These collections are brought to the laboratory where the hair is removed from the clusters by rubbing them over a piece of cheesecloth drawn taut over a small tray. The eggs are examined with a binocular microscope and the percentage of parasitism determined. It is quite easy to observe the *Anastatus* maggot within the gipsy moth egg and, with a little practice, this work can be done quite rapidly. It has been found that one cubic centimeter contains on an average 1,000 eggs, so that the eggs are measured, the parasitized ones counted, and the percentage of parasitism is thus determined. The collections are continued along the lines until the parasitism drops below 10 per cent. From the territory inside the 10 per cent limit on all the lines, egg clusters are collected during the winter to obtain material for further colonization. Last year five bushels of egg clusters were collected from this colony and were sifted by means of a special machine which was devised by Mr. C. W. Stockwell of the laboratory force. This sifter not only saves a great amount of labor, but eliminates, to a great extent, the irritation in the nose and throat caused by the dust and hairs which always results when this work is done by hand. This machine is made on the principle of the old-fashioned grist-mill, but is so adjusted that the eggs are not injured. It consists of two horizontal disks three feet in diameter, which are padded on the inner surfaces. The eggs are fed to the machine automatically from a box which rests on the top. The upper disk revolves slowly, removing the hairs from the eggs as they are worked toward the circumference where they fall on to a chute and assemble in a trough. The power is furnished by a small electric motor. The hair and dust are removed through a suction pipe by means of a small electric blower.

After the eggs are sifted they are spread evenly over the bottom of the trays. Several layers of cloth mosquito netting are placed over them and the trays are made dark and tight by covering with black paper. Holes are made in the side, into which glass tubes are fitted. As the non-parasitized gipsy moth eggs hatch, the larvæ crawl up through the netting and into the glass tubes from which they are destroyed by being placed in a jar of kerosene oil. Much of the silk spun by the caterpillars becomes entangled in the netting, so that the parasitized eggs are quite free from it. After hatching is completed, the parasitized eggs, dead eggs, and egg shells are taken from the trays and separated by means of another machine devised by Mr. Stockwell. The eggs run by gravity over a chute, and at a certain point, the egg shells and dead eggs, which are lighter than the parasitized ones, are drawn off by suction, while the heavier parasitized eggs continue on into a tube at the base of the machine. As one cubic centimeter contains on an average 1,000 eggs, these are measured and placed in

envelopes, one cubic centimeter to an envelope, sealed and put in a cool place until colonizing begins.

During the fall, *Schedius* are liberated as adults in colonies of about 3,500. If the infestation warrants, the colonies are placed along all the roads in a town, 200 to 300 feet from the roadside and about two miles apart. The *Schedius* are merely shaken from the tube, a tree nearby is marked with a letter "S" and banded with white paint, and a tree on the roadside painted with a letter "S" and an arrow pointing toward the colony. A map is then drawn showing the exact location of the colony and this map is filed with the colony note.

During the spring, *Anastatus* are liberated as larvæ within the host eggs, in colonies of approximately 1,000. As this species spreads at a much slower rate than *Schedius*, the colonies are placed in infested woodlands every quarter of a mile on each side of the road, about one hundred feet from the roadside. A small tin can which has three exit holes in the side is stocked with a colony and nailed to a tree. Each can has a cover which prevents the rain from getting in and also protects the eggs from birds. The exact location of the colony is marked on a blue print map of the town and two colonies in each town are marked in the field as are the *Schedius* colonies, except that an "A" is used instead of an "S."

In the fall of 1916, over 2,500,000 *Schedius*, all of which were bred at the laboratory were liberated in fifty-nine towns in New England. The previous spring over one hundred New England towns were colonized with *Anastatus*, using over 12,000,000 parasites. To obtain the latter material, five bushels of gipsy moth eggs were collected from over 1,200 acres of woodland. In order to colonize such an enormous amount of material during a period of six to eight weeks, it was necessary to use every available man. Several states coöperated with us in this colonization and without their aid and the use of motor vehicles, it would have been impossible to complete the work.

In order to determine the success of colonizations, collections of 100 gipsy moth egg clusters are made around the center of many representative colonies. After arrival at the laboratory, they are placed in eight-inch glass tubes, numbered, and a record is made of the number of parasites that issue. The collections show that a good per cent of the colonies are successful.

To determine the dispersion and increase of *Schedius*, four lines are run to the cardinal points of the compass, using as the center, the exact location where a colony has been liberated. Collections of ten egg clusters each are made at the center and at points, every 220 yards along these lines. For *Anastatus*, eight lines are run and the egg collections are made from the center and every 100 feet for 600 feet, then every

100 yards. These lines are run to the colony limits, which in some cases is nearly two miles. At the laboratory these eggs are sifted and

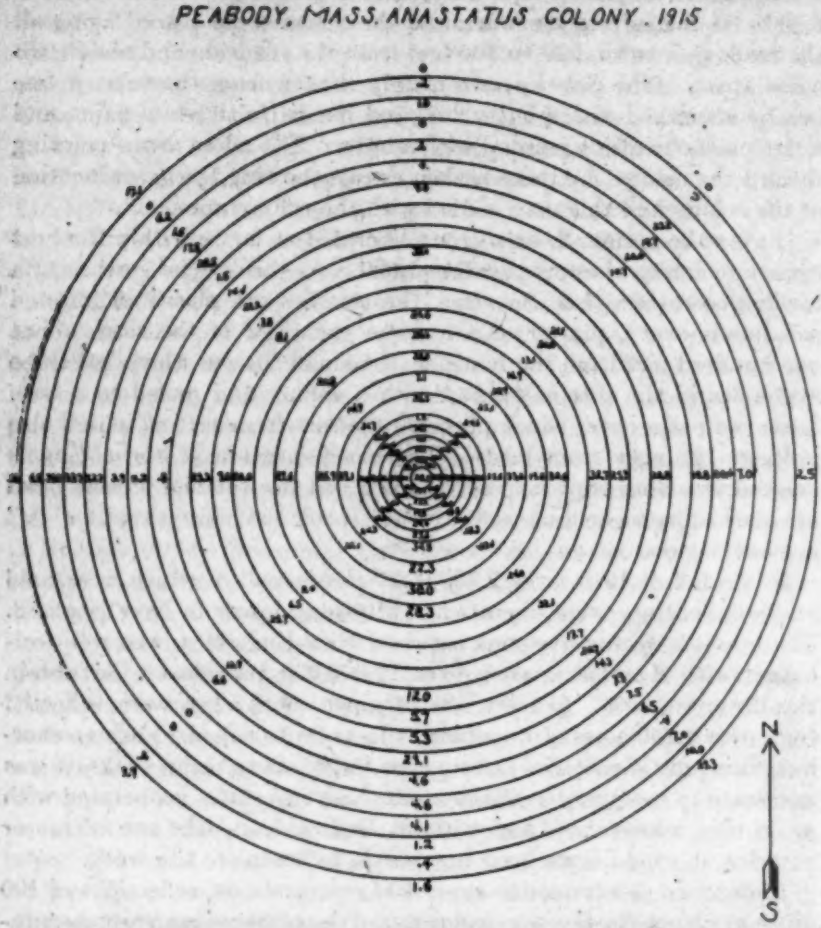


Fig. 7. The figures give the percentage of parasitism of the gipsy moth eggs at these points by *Anastatus bifasciatus*. In a few places it was impossible to make collections, such places are indicated by the absence of figures. The concentric circles represent distances of 100 yards, excepting the six inner ones which represent distances of 100 feet. The N. W. and S. E. lines run into other *Anastatus* colonies, which explains the high percentage of parasitism at the ends of these lines. This chart was prepared by Mr. R. Wooldridge and the photograph of it was made by Mr. H. A. Preston.

the amount of parasitism determined. As this work is done during the winter, the *Anastatus* larvæ are seen within the gipsy moth eggs and the parasitism by *Schedius* is determined by making a count of the

eggs that show the exit holes of this parasite. These percentages are then charted. From a study of such charts made over a period of years, the increase in percentage of parasitism and the yearly dispersion is determined.

I have tried to show by the examples of these two imported parasites, that as their seasonal histories and habits differ, so must the methods of their colonization. It takes time to develop the correct methods to use and if the preliminary work is hurried, much valuable material and information may be lost. The introduction of parasites is simply an attempt to assist in bringing about a proper natural balance in order to hold our imported pests in check.

The problem is complicated by many factors requiring careful and thorough investigation, if errors are to be avoided.

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PRESIDENT C. GORDON HEWITT: Is there any discussion?

MISS BRACE: Is any provision made for air in the breeding trays?

MR. S. S. CROSSMAN: The trays are not air tight but no special arrangement to admit air is necessary.

PRESIDENT C. GORDON HEWITT: Mr. J. W. McColloch will present the next paper.

## A METHOD FOR THE STUDY OF UNDERGROUND INSECTS[1]

By JAMES W. McCOLLOCH, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

With the establishment, in 1914, by the Department of Entomology of project No. 100, which deals with a study of those insects injuring the roots and germinating seeds of staple crops, such as white grubs, wireworms, and false wireworms, it was found necessary to devise some methods for rearing the various species concerned. Davis[2] describes a number of cages which he has found successful in the rearing of white grubs and the writer, after trying several of them, found the one- and two-ounce salve boxes the most satisfactory, because the individual insects could be followed throughout their growth. During the summer of the first year, an attempt was made to rear the insects in the field insectary, and under compost heaps, as suggested by Davis, during the winter.

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[1] Contribution from the Entomological Laboratory, Kansas State Agricultural College, No. 24. This paper embodies some of the results obtained in the prosecution of project No. 100 of the Kansas Agricultural Experiment Station.

[2] Davis, J. J., Cages and Methods of Studying Underground Insects. Jour. Econ. Ent., vol. VIII, 135–139, 1915.

The work had not progressed far until it was found impossible, owing to the wide range of temperature, to rear these insects under field insectary conditions. In summer, it was not unusual for the temperature to reach 100° or more and during the winter it fell to 20° below zero. Since these extremes were far in excess of those that would be encountered under natural conditions, they resulted in a high mortality. Inasmuch as it was desired to observe the insects during the winter, it was not feasible to place the insects under compost heaps during this period.

Another objection to placing the salve boxes under piles of compost is the difficulty in knowing just how much moisture is needed in the boxes. The writer has also found that unless exceptional care is taken the soil and food will mould in the course of three or four weeks and make the boxes untenantable. With these objections in mind, it was decided to try carrying the material through in a cave where the temperature could be kept above freezing and where the boxes could be examined at regular intervals.

In the fall of 1915, a temporary cave was constructed for this purpose. A hole three by five feet was dug six feet in the ground and the sides boarded up sufficiently to prevent caving in. A board roof was placed over the hole about five feet from the bottom and was covered with a foot and a half of dirt. A manhole opening was left in one corner for admittance. This opening was closed with a heavy door covered over with a few layers of burlap. The bulb of a soil thermograph was placed in the cave. The instrument itself was inclosed in a small box on the outside so that the temperature could be determined without opening the cave. A set of maximum and minimum thermometers were also kept in the cave as a check on the thermograph. With the approach of cold weather early in October, about twenty species of insects were placed in the cave and kept under observation during the winter. Every two or three weeks all the boxes were gone over, the soil changed, and fresh food supplied. Table I gives a list of the insects successfully carried through the winter.

All of the insects appeared to thrive under these conditions during the winter and the mortality was very low. The writer has been attempting to carry corn ear-worm pupæ through the winter for several years, but always with negative results because the mortality would be from 75 to 100 per cent. With the material kept in the cave, less than 25 per cent died. The behavior of many of the insects kept in the cave was checked with field observations to determine what variations, if any, occurred. Corn ear-worm larvæ, placed in the cave early in October, pupated at the same time as did those in a check kept in the field insectary. In the spring, the adults emerged during June which

is the normal time of emergence in the field. Grasshopper eggs hatched in the cave at the same time that eggs were hatching in the field. The larvæ of *Eleodes opaca* and *E. tricostata* pupated in the spring and the adults emerged at the same time that fresh adults were being found outside.

TABLE 1—LIST OF SPECIES CARRIED THROUGH THE WINTER IN THE CAVE

| Family | Species | Stage |
|---|---|---|
| Myriapoda | Julus sp. | Adults |
| Acrididæ | Melanoplus differentialis | Eggs |
| Tipulidæ | (undetermined) | Larvæ |
| Noctuidæ | Peridroma saucia | " |
| " | Heliothis obsoleta | Pupæ |
| Carabidæ | Harpalus sp. | Larvæ |
| Scarabæidæ | Lachnosterna knochii | " |
| " | " rubiginosa | " |
| " | " crassissima | " |
| " | " lanceolata | " |
| " | Ligyrus gibbosus | Adults |
| Elateridæ | Monocrepidius vespertinus | Larvæ |
| " | Melanotus communis | Larvæ and adults |
| " | Lacon rectangularis | Adults |
| Meloidæ | Epicauta maculata | Larvæ |
| Tenebrionidæ | Eleodes opaca | Larvæ |
| " | " tricostata | Larvæ and adults |

A study of the temperature records of the cave is very interesting. From October 11 to November 8, the average mean temperature was about 63° with a daily range of from one to two degrees. From November 8 to February 11, the temperature gradually fell from 62° to 37°, a drop of 25° in 95 days, or an average of about one-fourth of a degree per day. From February 11 to March 6, the temperature remained practically constant at from 37° to 38°. On the latter date it gradually began to rise. From January 17 to March 18, a period of 61 days, the temperature remained constant at from 37° to 40°. The daily fluctuation of temperature within the cave, with the exception of one day, did not exceed two degrees. There were 62 days when it remained constant, 101 days when there was a one degree fluctuation and 26 days when the range was two degrees. The average daily range of temperature outside for this same period was 21.5°, with extremes of 3 and 50°. On January 11 to 13, the outside temperature fell from 53° to −16°, a drop of 69°, while there was a drop of only 3° in the cave. The average mean temperature of the cave and the outside, together with the range of temperature in the cave, is shown in the accompanying chart (Fig. 8).

This temporary cave proved so successful that in the summer of 1916 a permanent cement cave was constructed. The floor of this

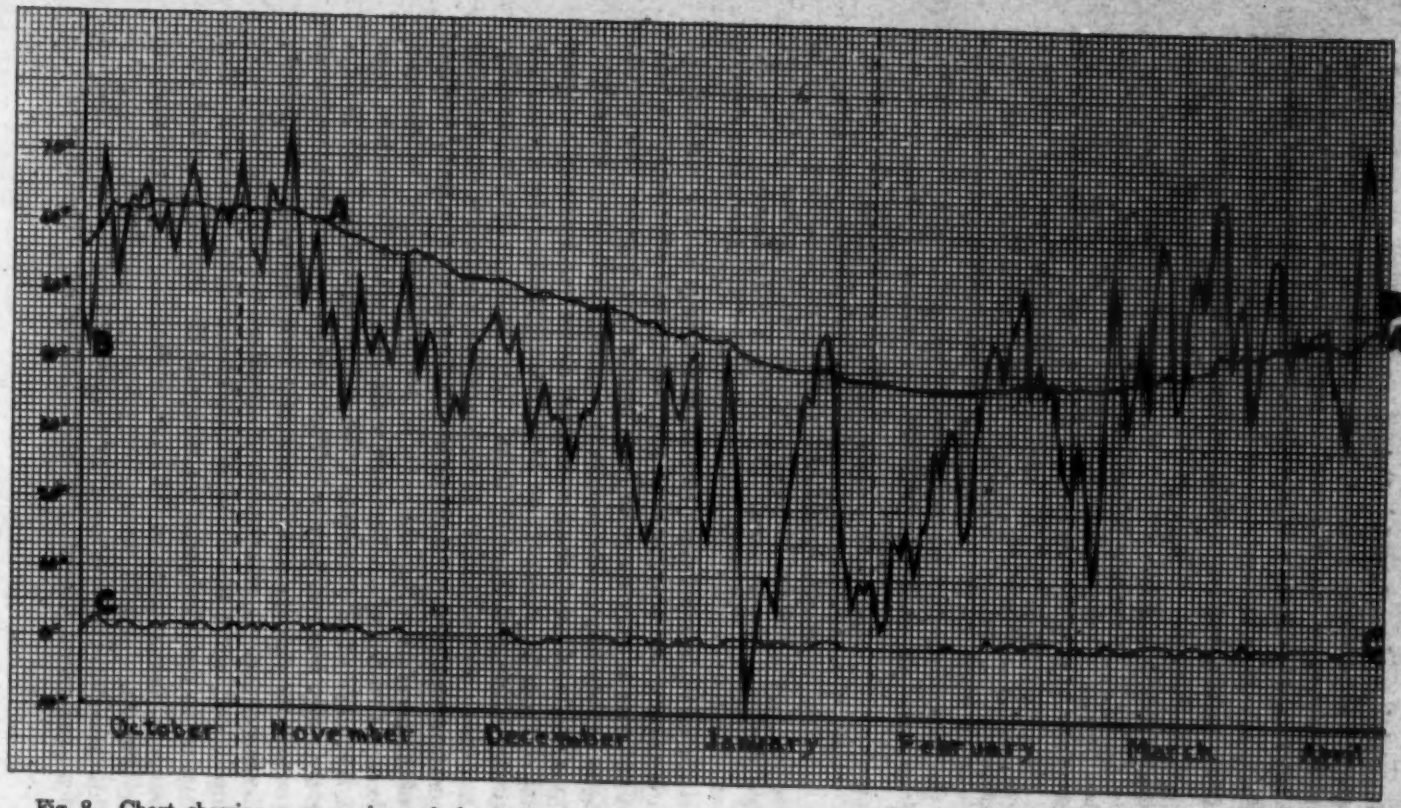


Fig. 8. Chart showing a comparison of the mean temperature of the cave and the outside, and the range of temperature in the cave from October 8, 1915, to April 15, 1916. A. Average daily mean temperature in the cave. B. Average daily mean temperature on the outside. C. Daily range of temperature in cave.

cave was placed eight feet below the surface of the ground and the roof two feet below the surface. The floor space of this cave is five by seven feet. The walls, roof and floor are six inches thick, and the roof is reinforced. The entrance is through a manhole at one corner with an iron ladder leading down to the floor. The advantage of the manhole type of entrance is that it does not cause much change of temperature when opened. The temperature was recorded in the same way as in the case of the temporary cave.

This cave was completed about the last of July and since then has been used in the rearing of white grubs, wireworms, and false wireworms, as well as a number of other species. It has proved even more satisfactory than the first cave and the temperature control has been even better. From August 1 to November 1, the temperature was held at from 75° to 65° and since then there has been a gradual decrease, amounting to about one-eighth of a degree a day. The daily fluctuation of temperature is also less in the cement cave. A number of experiments were made during the summer to determine what influence the cave had on the life-histories of various insects. Three generations of the chinch bug egg parasite (*Eumicrosoma beneficia*) were reared in the cave and the life cycle coincided with that of the check reared in the field insectary. Eggs of the false wireworms and corn ear-worm hatched in the same length of time as those in the check. During the time these experiments were being run, the temperature of the field insectary was varying from about 60° to 70° at night to about 100° during the day, with a mean of about 80°. The temperature of the cave was practically constant, being about 78°.

The possibilities of this method of rearing insects, especially of subterranean forms, seems to be very promising. The temperature can be controlled to a much better extent than in many forms of elaborate apparatus. The fact that the daily range of temperature is so small makes it possible to hold it at any desired degree for weeks at a time. It is very probable that a carbon electric light connected with a switch in the thermograph house would make it possible to quickly rectify any drop in temperature. The conditions encountered in the cave did not materially influence the insects under observation and the length of the stages was the same as in the checks reared in the field insectary. In fact, the conditions in the cave appeared to approximate those that would be encountered in the field by the subterranean forms studied.

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PRESIDENT C. GORDON HEWITT: This paper is now open for discussion.

MR. FRANKLIN SHERMAN, JR.: The paper just presented covers a

study of certain little known insects. It is very important to determine these matters. In North Carolina we are attempting to make an insect survey and are preparing a tabulated list of the insects of the state. We have considerable information on hand and would be glad to furnish data that would be of interest to others. I mention this now so that any of the members may take advantage of the opportunity if they so desire.

PRESIDENT C. GORDON HEWITT: I am sure the members will welcome the spirit shown by North Carolina. I will now call for Mr. Zappe to read his paper.

## EGG-LAYING HABITS OF DIPRION SIMILE HARTIG[1]

By M. P. ZAPPE, *New Haven, Conn.*

This European sawfly was first found in Connecticut during the annual nursery inspection in August, 1914. At that time we found many nearly full grown larvæ and a few cocoons. During the summer of 1915 some observations were made on its life-history, but the facilities for carrying on this line of work were not very good. The following spring (1916) an outdoor insectary was built in which were planted several species of pine to be used as host plants.

### OVIPOSITION

As soon as the female sawflies emerge from the cocoons in cages, they begin to run aimlessly about, going all over the pine twigs. This continues for an indefinite period of time, usually about twenty-four hours; then they begin to deposit eggs. When the female is ready to oviposit, she places herself on the pine leaf or needle facing the tip. She grasps the needle securely with her tarsi, the hind legs extending a little beyond the end of her abdomen. The ovipositor is then inserted in the edge of the needle, and she begins to saw a slit in it, working from the base toward the tip. When the incision is about one tenth of an inch long, she rests for a few seconds and then lays the egg in the slit, gradually drawing the ovipositor backward and out of the needle. This leaves a ridge of resin and sawed pulp from the leaf as a covering for the egg. The sawfly then moves forward and inserts the ovipositor immediately in front of the egg just laid and begins to saw a place for another egg. The time required to lay a single egg is about four minutes in *Pinus excelsa* and about five minutes in *Pinus densiflora*.

[1] Jour. Econ. Ent., vol. VIII, p. 379, June, 1915; vol. IX, p. 281, April, 1916.

### Hosts for Egg-Laying

In captivity the female sawflies have laid eggs in several species of pine as follows:

| | |
|---|---|
| *Pinus excelsa*, Japan or Bhotan pine<br>*Pinus cembra*, stone pine<br>*Pinus flexilis*, limber pine<br>*Pinus strobus*, white pine<br>*Pinus koraiensis*, Korean pine | Five needles |
| *Pinus sylvestris*, Scotch pine<br>*Pinus densiflora*, Japanese red pine<br>*Pinus montana*, mugho pine<br>*Pinus resinosa*, red pine<br>*Pinus ponderosa*, bull pine<br>*Pinus laricio var. Austriaça*, Austrian pine | Two needles |
| *Pinus rigida*, pitch pine | Three needles |

A few eggs were also laid singly on white spruce, although attempts to obtain eggs on hemlock, larch, Japanese umbrella pine, and white fir, failed. Out of doors the sawflies showed a decided preference for the five-needled pines, although larvæ have been found feeding on other species. *Pinus excelsa* seems to be preferred above all others.

### Parthenogenesis

Copulation was not observed and seems to be wholly unnecessary, as the eggs develop and hatch just the same if males are not present. Apparently it makes no difference as to the number of eggs laid whether or not males are present at the time the females are ovipositing. Some oviposit when males are present, others do not; the same is also true when males are absent.

In three cases the adults reared from eggs laid by virgin females were all males, but this may not hold true upon further investigation. In fact, some of the second brood 1916 cocoons are of large size and look as if they might yield females.

### Number of Eggs Laid

The female sawflies usually begin to oviposit about one day after emerging from the cocoons and live for about seven days, while those individuals which do not oviposit die in four or five days. Length of life of males varies, some live longer than the females and some do not.

Upon dissecting the bodies of females from overwintering cocoons an average of 58 eggs per female was found, while the eggs in a female

of the first brood averaged 76. The highest number of eggs laid by a single female was 128. This is a larger number of eggs than we ever dissected from any female's body. The average number of eggs laid was 64. The number of eggs laid in a single needle varies from 1 to 20, the average number being 6. The eggs are usually laid in needles of the previous year's growth, if any are present. The majority of the eggs for the first brood in Connecticut hatch during the first half of May, while those for the second brood hatch early in August, but the broods overlap. It sometimes happens that some of the first brood of females are so late in emerging that the eggs which they lay do not produce larvæ until after some of the second brood eggs have hatched.

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PRESIDENT C. GORDON HEWITT: Does any one wish to discuss this paper?

MR. R. L. WEBSTER: I am much interested to know that Mr. Zappe reared sawflies from unfertilized eggs. In work with *Harpiphorus maculatus*, I had a similar experience, although I secured one female from an unfertilized egg. I am wonde ing what the experience has been of other men who have worked with sawflies.

MR. MAX P. ZAPPE: By next spring I may know more about this as I now have several cocoons reared from eggs of virgin females from which adults have not yet emerged.

PRESIDENT C. GORDON HEWITT: In my own study with the larch sawfly, *Nematus erichsonii*, the female was quite common in that species but both sexes were reared from unfertilized eggs.

If there is no further discussion, the next paper will be given by Mr. Manter.

## NOTES ON THE BEAN WEEVIL (ACANTHOSCELIDES [BRUCHUS] OBTECTUS SAY)

By J. A. MANTER, *Storrs, Conn.*

The common bean weevil is considered by many entomologists as the most destructive pest attacking beans. It is especially injurious in the Southern States. This beetle was first described by Thomas Say in 1831 but did not attract notice as an economic species until 1860 when infested beans were sent to Doctor Fitch from Providence, R. I. During the next ten years it was reported from several widely separated states and now is common throughout the country.

At first the bean weevil was credited with habits similar to those of the pea weevil (*Laria pisorum* L.) and the same control measures were recommended for each. When the life-history was studied it

was found to differ in several important points and to require somewhat different methods of control. These errors were copied and recopied in many of the bulletins of our experiment stations for it was not until about twenty-five years ago that some of the most important phases of the life-history were correctly ascertained. Doctor Lintner proved in 1891 that the bean weevil bred continuously in dried beans, which was the most important observation made. There are a few minor observations still to be corrected or yet to be made.

## The Egg

Doctor Chittenden gives the measurements of the egg as .55–.7 mm. long, being 2½ times as long as wide. The average of several eggs which I have measured proved to be .84 mm. long and .30 mm. wide at the greatest diameter. The smooth white eggs are cylindrical ovate and oftentimes slightly curved so as to resemble bananas in shape. In storage the eggs are laid loosely in the container, at times being fastened to the beans or receptacle and also may be deposited in the exit holes in the beans. They may be laid singly or several in a cluster. Lintner states that the "eggs are laid narrower end lower when attached at an angle." I found of 261 eggs attached at an angle that 134, or more than one half, were placed with the larger end lower. The eggs are so light that it would take nearly 40,000 to weigh a gram. The lengths of the different life stages vary with the temperature and the season. In my experiments the egg stage has varied from 7 to 17 days, the average for December at room temperature being 10 days. Just before hatching the dark colored head of the larva shows through the walls of the egg shell.

## The Larva

The larva leaves through an irregular opening made in the larger end of the egg. At first it has long legs with which it crawls about seeking a suitable place at which to enter the bean. Lintner states in his seventh report "it is highly probable that the aid given the larva by the walls of the egg shell while still within it in concentrating, guiding, and sustaining its muscular efforts, or that afforded by some surface in contact as of an adjoining bean or the enclosing bag or jar, is essential to its effecting an entrance." I had noticed that the larvæ always entered the bean where it was in contact with another bean or other object. Beans were supported on the ends of pins and several larvæ placed on each. Many of them crawled down the pins while a few entered the beans alongside of the pins. None entered elsewhere. A small amount of vaseline was placed on the next lot around the points so that the larvæ could not leave by this route nor burrow into

the beans at this point. No larvæ entered the beans. Larvæ in the act of chewing their entrance holes have their bodies arched against some surface as if braced against it. I do not think the larvæ secure any aid from the walls of the egg shell but evidently they do require a position where they can brace themselves and so exert their muscular efforts to the best advantage in order to penetrate the hard coating of the bean. They take advantage of any break in the surface of the bean and also the entrance hole left by another. Several larvæ may enter through the same hole, each branching off into a new channel soon after entering and taking up a feeding area of its own. The entrance hole has a diameter of about .232 mm. and is filled with fine white powder, some of which may be scattered around on the surface. The legs are lost soon after entering. The number of days required for the larva to become full grown has varied from 27 to 54.

### The Pupa

The pupal cell, lined in white, is located adjacent to the surface of the bean with some of the testa chewed away, so that only a very thin translucent membrane separates the insect from the outside world. This area becomes dark when the pupa beneath changes into the adult. The snowy white pupa gradually darkens, the eyes, mouthparts, and wings being the first to change. The time elapsing from the formation of the pupa to the emergence of the adult has varied from 8 to 20 days.

Doctor Lintner states that the lid of the exit hole is not formed by the larva but by the beetle and that it is not formed at the semi-transparent spot made by the larva "but removed a little therefrom, perhaps slightly more than the cell's length." From my observations I find that the lid is cut out of the translucent area made by the larva. The adult cuts around and through the circumference of the lid so that it can be pushed open or away. Thus the larva and the adult each have their share in forming the lid of the exit hole.

### Adult

The adults may mate almost immediately after emerging and the female may even lay eggs within 24 hours. Females kept away from beans will refrain from laying eggs for several days while those with beans will lay soon after mating. The egg-laying period varied from 3 to 18 days; the average for 37 females was 8 days. The number of eggs laid by individual females varied from 5 to 75 with an average of 45 eggs. The length of life of the adult in stored beans is not long, usually about 10 or 12 days if they are allowed to mate and oviposit normally. I think that the female lives the longer. There is a wide

variation in the size of the beetles as the largest may weigh five or six times as much as the smallest.

### Control

Fumigation with carbon bisulphide is the common method of control. If one has only a small quantity of beans to treat he may not wish to use this method. The bean weevil in all its stages may be killed by heat without injuring the beans. The embryos are killed in 10 minutes at 52° C.; newly hatched larvæ, in 7 minutes at 55°; full grown larvæ in beans, in 20 minutes at 55°; pupæ in beans, in 25 minutes at 55°; and adults in 4 minutes at 55°. In practice these short exposures will not be sufficient but the length of treatment must vary with the quantity of beans and the type of receptacle. It required nine hours for the center of two quarts of beans enclosed in a tight paper bag to reach the surrounding temperature of 55° C. The seed should be spread openly in shallow layers and subjected to a temperature of 55° for about an hour. According to the investigations of others the germinating power is not injured at this temperature. The bean weevil will not breed at cold temperatures. It would be a good practice to place beans in cold storage or to expose them to the cold winter weather.

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President C. Gordon Hewitt: The last paper on the program will be given by Mr. I. W. Davis.

## THE PRESENT STATUS OF THE GIPSY AND BROWN-TAIL MOTHS IN CONNECTICUT

By Irving W. Davis, *New Haven, Conn.*

The gipsy moth of Europe was first taken in Connecticut in Stonington, which lies in the southeastern corner of the state, in July, 1905, when Mr. Ernst Frensch, an amateur collector, caught two female moths. This was not reported, however, until March, 1906, when it became known through correspondence between Doctor Britton and Mr. Frensch. Scouts were immediately employed, who determined the extent of the infestation, which contained less than a square mile of territory, and control measures were practised. This work was continued from that time until 1914, but no trace of the pest was found from 1911–1913, and the windspread of that year, which infested several towns in the eastern end of the state, is now believed to have caused this reinfestation.

Late in the year 1909 a colony of gipsy moths was located at Wallingford, about fifteen miles north of the city of New Haven, and a force of men under Mr. D. J. Caffrey (now of the Bureau) began the work of extermination. This work was done very thoroughly and although over 8,000 egg-clusters were destroyed that first winter, at the end of four years no trace of the moth was found. The scouting, however, was carried on for two years thereafter.

Following the discovery of five gipsy moth caterpillars at the Stonington infestation in the summer of 1913, a force of Federal scouts was sent to Connecticut, and during that winter found ten towns along the eastern border of the state slightly infested with this pest. None of these localities contained any old egg-clusters, and it is, therefore, believed that the spread occurred during the spring of that year. In the winter of 1914 this area was again scouted, together with the territory just to the west of the infestations, and ten more towns were found infested, but as before the infestations were light, in many cases only a few egg-clusters being found in a town. In the fall of 1915 on account of increased appropriations, the state was able to put more men in the field than formerly, although the Federal men still scouted the outside towns. During that winter one new town was found to contain the gipsy moth, making a total of 21 towns which together have an area of about seven hundred and thirty square miles. Five towns, however, where the moth had been taken in previous years were found free of the pest, and the number of colonies was greatly reduced.

Wherever egg-clusters have been found, they have been soaked with creosote, and in the larger infestations all underbrush has been cut and burned. Tanglefoot bands are applied the following spring to all trees, including and within 100 feet of the infested trees. In 1916, 13,165 such bands were applied. Sixty of the larger infestations, especially those showing caterpillars, were sprayed in June with arsenate of lead.

The heaviest infestations at the present time are in the northeastern corner of the state with scattering colonies south to the coast but in no locality have they been found in sufficient numbers to cause any noticeable injury. The largest colonies have consisted of 400 egg-clusters, but only two such have been found. The scouting work which has been done thus far this winter gives evidence of another, but shorter, windspread than that of 1913, for in the northeastern corner of the state a large number of infestations have been found which contain but a single egg-cluster each, and there is a marked falling off in these as the work is carried westward.

The brown-tail moth was first found in Connecticut at Thompson

in the spring of 1910, and as in the case of the gipsy moth, the heaviest infestations have been confined to the northeastern corner of the state. During the winter of 1910–1911 several towns in this section were scouted and a total of 7,133 winter webs were destroyed. Since that time the winter scouting has been continued, and at present there are 72 of the 168 towns in the state that are within the quarantined area.

The last legislature passed a law which provided that the towns were to do the moth work within their limits, whenever the state entomologist should deem it necessary, and through this means four towns, namely, Putnam, Thompson, Woodstock, and Pomfret were scouted in the winter of 1915–1916 and a total of over 14,000 webs were destroyed. It has also been our practice to have the towns bordering the infested district scouted, and if these are found to be infested, to scout to the west until no evidence of the pest was found. During the last two years no new towns have been added, and a marked decrease in the number of webs in the border towns has been noticed.

Some of the towns in the older infested areas have been examined this winter to ascertain the seriousness of the infestations, but so few webs have been noticed, that it is doubtful if it will be necessary to require any of the towns to do that work this winter.

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(At the close of the business session, which has already been reported, the meeting adjourned.)

A. F. BURGESS, *Secretary*

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## Meeting of Section on Apiary Inspection

The Section met in the American Museum of Natural History, New York, December 27, 1916. The following persons were in attendance.

E. G. Carr, New Egypt, N. J.; E. F. Phillips, Washington, D. C.; Franklin Sherman, Jr., Raleigh, N. C.; George H. Rea, Raleigh, N. C.; C. S. Bukurth, New Brunswick, N. J.; George A. Dean, Manhattan, Kansas; H. B. Hungerford, Manhattan, Kansas; Frank C. Pellett, Atlantic, Iowa; E. N. Cory, College Park, Maryland; James S. Hine, Columbus, Ohio; Max Kisliuk, Jr., Columbus, Ohio; Charles A. Weigel, Columbus, Ohio; G. W. Underhill, West Raleigh, N. C.; H. Spencer, West Raleigh, N. C.; J. A. Manter, Storrs, Conn.; P. T. Barnes, Harrisburg, Pa.; H. E. Backus, North East, Pa.; J. G. Sanders, Harrisburg, Pa.; E. D. Ball, Madison, Wis.; George G. Atwood, Albany, N. Y.; A. F. Burgess, Melrose Highlands, Mass.; B. N. Gates, Amherst, Mass.; T. J. Headlee, New Brunswick, N. J.

A number of interesting papers, published elsewhere in this report, were given and generally discussed by those present.

Dr. T. J. Headlee reported that he had conferred with the membership committee as instructed at the Columbus meeting, relative to having all apiary inspectors admitted to associate membership in the American Association of Economic Entomologists, and that this committee gave no definite promise to comply with the request but would recommend any to associate membership who could qualify according to the requirements of the Association.

The committee appointed to draft a form for reporting apiary inspections submitted an outline which was acted upon, item by item, and finally adopted in the form given below:

REPORT OF APIARY INSPECTION

(STATE.....DATE).....
Number of apiaries visited.....
Number of apiaries revisited during season.....
Number of colonies of which information is gained.....
Number of colonies carefully examined.....
Number of colonies found with American foulbrood.....
Number of colonies found with European foulbrood.....
Number of colonies found with sacbrood.....
Number of permanent inspectors employed.....
Number of temporary inspectors employed.....
Number of days' service of temporary inspectors.....
Per diem of temporary inspectors.....
Cost of inspection per colony.....
Reason if any for large cost per colony.....
.....
Outline of policy pursued.....
.....
.....
.....
Official in charge.....

It was moved by Dr. E. D. Ball that a committee be appointed to collect, file and disseminate the information secured from these reports. Motion carried.

E. F. Phillips, Morley Pettit and G. M. Bentley were appointed on this committee.

Dr. B. N. Gates moved that these reports be made in duplicate and mailed to the committee chairman as soon as the data are available. Carried.

Dr. E. F. Phillips moved that the Association of Economic Entomologists be requested to designate this section as the Section on Apiculture. Carried.

Dr. B. N. Gates was elected Chairman of the Section and N. E. Shaw was reëlected Secretary.

# SOME NEW AND PRACTICAL METHODS FOR THE CONTROL OF EUROPEAN FOULBROOD

By E. G. Carr

Whether the treatment for the control of European foulbrood, without destroying the combs, which shall be discussed, is new or old, it has received little or no official endorsement up to the present. The advantage of a practical method whereby the diseased brood combs are easily made fit for further use is so great that it seems worth while to encourage every effort made with that end in view.

There are three principles involved in the treatment of European foulbrood without destroying the combs. These are, a strong colony, the cessation of brood rearing in the diseased combs for a time and good Italian stock.

Occasionally the disease disappears from a colony with only two of these conditions present.

Many working on the problem have suggested requeening, queenlessness and Italian stock, either singly or in combination.

Simmons[1] in 1904 gave the combination practically as now used, but it seems to have attracted but little attention until 1905 when it was published in the November 1 issue of *Gleanings in Bee Culture* and called the Alexander treatment. Mr. Alexander claims to have been using this method for three years when it was published. He does not say it was original with him nor how he came by it.

At this time the method was tried by many and while a few reported success, the majority reported failure.

This apparent failure of the plan put a check on its further trial by many. In fact, a great cry of protest went up from beekeepers and bee-inspectors and the editor of *Gleanings* regretted having published the plan.

It is a common fault with beekeepers (it may be true also of others) to adhere strongly to their own preconceived notions and, unconsciously perhaps, modify a plan so that it lacks some essential feature. This is just the way all failures of this plan with which the writer is familiar, came about.

## The Strong Colony

The first step in treating a colony having European foulbrood by this modified method is to make it strong if not already so. The chances are much against a colony infected with European foulbrood being strong. However, since some colonies show a high resistance

[1] Simmons, S., 1904. Modern Bee Farm, revised edition, London.

to this disease, some may be found strong notwithstanding the fact that they are diseased.

No one who has not had the opportunity to note the different ideas among beekeepers as to what constitutes a strong colony, can form an idea of this difference. So great is it, that what one would call a strong colony another might consider only a nucleus.

Too small a colony was often the cause for failure to overcome this disease by this modified treatment.

It is highly desirable that the colony be strong in *young* bees since these are the ones which are credited with cleaning up the combs. Economy demands that the colony be properly strengthened without an unnecessary drain upon the strength of other colonies, hence it is desirable to know the minimum strength of a colony which may reasonably be expected to clean out the disease.

Doctor Miller and the Dadants have been successful in combating European foulbrood by the dequeening plan and they agree on the amount of brood and bees in the colony necessary for success. While the size of hive and frame used by each is different, they consider an amount of brood approximating that equal to five Langstroth size frames well filled, or about 500 square inches, and enough bees to cover well six Langstroth size frames, sufficient.

To secure the proper strength, adding to the weakened colony frames of emerging brood is usually recommended. When this is done, frames of comb must be taken from the infected colony to make room for the added frames of brood and these removed frames may be a source of infection when placed in another hive. For, it must be borne in mind, this plan makes no provision for the destruction of combs. An equally effective and safe way is to shake combs of bees in front of the colony to be strengthened. The old bees fly back to their hive and the young bees enter the colony needing them.

## Dequeening

The object of dequeening, or caging the queen within the hive, is to stop brood-rearing; thus checking the multiplication of the bacterium responsible for disease by bringing on a dearth of suitable soil in which it may develop, and giving the bees an opportunity to catch up with their house cleaning. Simmons did not give any definite time for leaving the colony queenless, but the plan as given by Alexander calls for 27 days during which no eggs are produced in the hive. His theory was that all brood should be allowed to emerge before the deposition of eggs was allowed.

Even the most casual observer has not failed to note the striking difference in the ability or inclination of different colonies to clean out

diseased larvæ. This may be accounted for by the greater or smaller proportion of young bees in the colony or by the difference in the race or strain of bees. However this may be, the economical management of the apiary demands that a colony be without a laying queen only so long as is necessary to accomplish a desired result.

Doctor Miller, in applying this so-called Alexander treatment, made an error by giving a *laying queen* at the end of twenty-one days instead of *a ripe cell*. The period of no egg production in the hive was thus reduced from 27 to 21 days. Further experimentation has resulted in overcoming the disease by a break of ten days in egg production, this reduction in time being governed by the amount of infection and the activity of the bees in cleaning up. It is clearly seen, then, that to fix an arbitrary limit to the time of queenlessness would unnecessarily interfere with the work of some colonies.

### Giving a Good Italian Queen

The word "good" as here used really means a queen whose offspring show disease-resistant qualities. It is entirely possible that such qualities might be found in any race of bees, but since the Italians have proven to be resistant, a good Italian queen is usually specified.

Many have failed at this point of the treatment and through no fault of theirs. Requeening is sometimes done with purchased queens and unfortunately not all queens are Italians which are sent out under that name and, further, not all Italians are equally good at cleaning out European foulbrood.

Doctor Miller has, with good results, practised caging the queen in the hive. Like results may be had by anyone under like conditions, which are exceedingly strong colonies, vigorous bees and a small amount of infection in the hive. This method appears questionable, since it may safely be assumed that the bees of a colony which is attacked by foulbrood have a susceptibility to disease which should be bred out. However, substituting a young queen reared from selected disease-resisting stock cannot be other than beneficial.

### Other Modifications of the Same Principles

Instead of deposing or caging the reigning queen success is also had in combating this disease by causing the bees to construct a new brood nest, thus bringing about a period of no brood-rearing in the infected combs. There is no reason to expect success with this plan unless there is a heavy honey flow at the time. The principle appears to be the two or three days' break in egg laying reduces the food for the bacillus, the honey flow furnishes an abundance of healthful food for the larvæ and gives a stimulus to the cell cleaners and the cells which

contained diseased larvæ are quickly and thoroughly prepared for the incoming nectar.

The actual operation is to put the queen in a hive with full sheets of foundation, over this an excluder and the diseased combs over all.

The activity of the bees in cleaning out European foulbrood during a nectar flow from buckwheat has often been remarked. This has been accounted for by the supposed presence of a large amount of acid in buckwheat nectar. Acting on this theory some have fed a mild acid to diseased bees and reported good results.

Latham[1] in 1915 did much to bring this into prominence although Cushman[2] suggested it in 1890. Latham's plan is to give the infected colony a daily dose of lemonade. This is made of 10 ounces of sugar, the juice of one lemon and one-half pint of water.

Since it is an established fact that a honey flow (natural or artificial), often causes European foulbrood to disappear, the effectiveness of the lemon juice has been questioned and it has been suggested that a daily feed of syrup would be equally effective.

To avoid the trouble of making the lemonade one beekeeper has used an ounce of citric acid to a gallon of syrup and claims good results. Further testing is needed to prove the value of the acid treatment.

Exception has been taken to recommending the Alexander plan to all persons having bees, it being considered practical for advanced beekeepers only. There is some ground for this objection, but it is believed that anyone with sufficient skill and knowledge of beekeeping to successfully treat a colony with European foulbrood by the shaking plan will be equally successful with the dequeening method. Further, since less work is involved it is often easier to get the beekeeper to do the work.

On the other hand, it must be admitted that a host of bee-owners will fail with either treatment and the only remedy which is effective in their hands is the destruction of the colony.

## PROBLEMS OF BEE INSPECTION

By Frank C. Pellett, *Atlantic, Iowa*

I must confess that I have modified my views concerning bee inspection each year of the five that I have served as state inspector of apiaries of Iowa. New difficulties have presented themselves each season, while some of the former ones have become simplified. I have at last concluded that we have been working along wrong lines and

[1] Latham, Allen, 1915, Gleanings in Bee Culture.

[2] Cushman, Samuel, 1890, Bulletin No. 9, Rhode Island Experiment Station.

that the plan now in operation in most states is not calculated to bring the best results with the small appropriations available.

In the beginning the appearance of bee diseases known as foulbrood was a matter of grave concern to the beekeeper. Little was known about either form, and methods of control were not certainly understood. Practical men had found that by removing the bees to a new and clean hive and destroying the old combs, including brood and honey, the infection was frequently eradicated.

The beekeepers were poorly organized and were slow in bringing their needs to public attention. As a result, both European and American foulbrood had spread into most of the northern states, before a serious attempt at control was undertaken. All the laws for the control of bee diseases with which I am familiar are similar in their general provisions. The sole idea seems to be to give a state officer authority to examine all the colonies in localities where disease is known to be present, and, by the use of a rigid quarantine, insist on the treatment or destruction of the diseased colonies. Had prompt and decisive action been taken when the trouble first appeared, it might have been stamped out as foot and mouth disease seems to have been.

The first and greatest difficulty which an inspector is called upon to meet, is to cover thousands of square miles of territory in which are located thousands of colonies of bees, with an appropriation not sufficient to cover 20 per cent of the territory efficiently.

Next to the lack of funds with which to follow the directions laid down in the law, the great problem is to get men who are sufficiently familiar with bee diseases and who have had sufficient experience in dealing with the public to enable them to do efficient work. In most states the work is paid for on a per diem basis. There is a rush of work for a few weeks during the honey producer's harvest and nothing to do the rest of the year. Since a man who is competent to do the work of an inspector can make several times as much for the same time spent, in an apiary of his own, it is necessary to be constantly educating young men who are willing to spend their vacations in this work for the experience gained. One who has not been responsible for such work under such conditions can hardly realize the amount of irritation that is constantly arising because of mistakes of one kind or another. As soon as a man becomes trained to do the work in an efficient and satisfactory manner, he is sure to find a more attractive opening elsewhere.

Much tact is required to deal with men who know little about bees and care less. In the average locality where inspection is new, the inspector will find men who don't believe that bees are subject to any

such disease as foulbrood; men who defy his authority and dare him to come on the premises; men who regard the inspector as a grafter and believe that the office was created by the politicians for the purpose of providing him with a job, and last, and often rather infrequently, men who want to learn something about the bees and who welcome the inspector with open arms. If all were like the last named, inspection would be a real joy, but to convince the others that it is to their interest to take advantage of the services of the inspector and that they will not suffer because of his presence requires much diplomacy. A man must never be in a hurry, must never be arbitrary, yet must be firm. I have become fully convinced that the police powers for the purpose of enforcing the provisions of the law should be in the hands of some other officer. The mere fact that the inspector is given so much power adds greatly to his difficulties. Knowing that if disease is found the inspector is given authority to demand the destruction of the diseased colonies makes the uninformed dread his coming and place every possible obstacle in the way of having the bees examined.

I might very easily extend this paper to great length by outlining in detail specific instances of such problems as above enumerated, but the facts will be too apparent to require extended discussion. The real problem after all is to find a remedy that will meet the trying conditions. There seems to be little of permanent value in the work of the inspectors aside from the education that comes to the individual beekeepers as a result of the personal contact. Even though sufficient appropriations of funds and trained men could be secured to stamp out foulbrood from any single state, the chances are that it would not remain free from the contagion for a single year. The fact that it is present in all the northern states and most of the southern ones as well, makes it improbable that the diseases can ever be permanently eradicated. It very frequently happens that an inspector will be congratulating himself upon the fact that by thorough work in a given locality he has cleaned up the disease, when lo! it suddenly appears again with a shipment of honey or bees from some outside location.

Since all are agreed that the problem is now one of education, why not make it an educational problem instead of a quarantine regulation? When an inspector goes into a locality and is required to examine all the bees there, entirely too much time and money is required, considering the limited resources available for the purpose. Apiary demonstrations such as are now held in Ontario under direction of Prof. Morley Pettit would seem to be much more efficient. If the beekeepers of the surrounding country are invited to spend a day in an apiary where disease is present, much more can be accomplished looking toward the control of foulbrood. All who take sufficient interest

to attend the demonstration can be shown disease in its various stages and also be shown how to treat each colony as its condition demands. Thus in one day ten to fifty persons can be given actual instruction in recognizing and treating disease, instead of spending the same amount of time in examining the colonies in one large apiary. Under present conditions the inspector does not have sufficient time to give each man visited sufficient instruction to enable him to care for the diseased colonies properly, and it often happens that the inefficient owner will not understand directions correctly and will succeed in spreading the disease instead of checking it.

In my annual report which has recently been filed with the governor, I have recommended that the present office of state inspector of bees, be abolished altogether. In its place I have suggested that a man be employed on full time in the extension department of the college of agriculture for the purpose of holding apiary demonstrations as above mentioned, during the summer months, and lecturing on marketing, production and other subjects of vital interest during the remainder of the year. I would not repeal the laws requiring proper attention to diseased colonies, and our proposed bill provides that the state apiarist can be called on petition of the beekeepers in any locality to examine bees which are supposed to be diseased. If he finds disease to be present, he is required to give the owner written instructions for the proper treatment or destruction, which instructions the owner is required to comply with within the time specified. However, the enforcement of this law is left in the hands of others, and he is not handicapped by being required to see that his own instructions are followed.

According to this plan it is hoped that by paying a salary for full time, a competent man can be secured for the work. By making his work purely educational in character it is hoped that he will be able to reach many more people, and to avoid the prejudice which is apparent under the present law. I realize that this plan is not perfect and that valid objections may be raised, but in a state like Iowa where 50,000 square miles of territory must be covered, and where there are 30,000 beekeepers, big and little, I am convinced that far more can be accomplished with the small funds which can be secured for this work, than by the present plan. It is hardly within the province of the state to examine every individual colony of bees in localities where disease is present, any more than it is to examine every pig where there is an outbreak of cholera, or other animal disease. Quarantine methods are justified and necessary in dealing with some new malady which has not yet become generally spread, but it is a hopeless task to undertake to eradicate any widespread contagion by these methods. I am fully convinced that this plan will shortly be abandoned and educational methods substituted very generally.

## THE RESULTS OF APIARY INSPECTION

By E. F. Phillips

The inspection of apiaries in the various states is unfortunately conducted according to many different systems and in some cases with little apparent system. This work cannot be cast in a mold, because of the wide divergence of conditions in the various bee-keeping regions of the United States, but it would seem possible to standardize the work to some extent by discussions in this association and elsewhere. To show the divergence more clearly, some of the differences in plans may be mentioned. In some states it is the policy to do intensive work by attempting to visit and advise all the beekeepers in a locality before the inspector leaves; in other cases inspection is made only on request and only a few beekeepers are visited on each trip from the central office. In some cases emphasis is placed on work with the individual beekeeper; in other states meetings and demonstrations are held to reach a larger number of beekeepers. In some states the supervising officer has a bird's-eye view of the situation throughout the state, made possible by adequate records and maps; in other instances the inspector has no such efficient records and wanders more or less aimlessly about, helping wherever he can but without a broad outlook. To obviate some of the grosser errors, the Bureau of Entomology has advised supervision of the work by an already existing office, not only to save administration expense, but especially to make the work constructive, comprehensive and efficient. The history of inspection proves conclusively the advantage of such a system and shows the relative inefficiency of an independent inspector.

The title of the present paper indicates a desire to know whether the apiary inspection is profitable. At the request of beekeepers, the various states are spending thousands of dollars annually in this work. It has been in operation on an ever increasing scale since the first law was passed in Wisconsin in 1897 and enough experience is available to warrant the demand for a showing of results.

If conclusions are based on observations of a general character, one must believe that inspection is a decided benefit. Even in those states where there is little or no system and where the most careless work is done, we find individual beekeepers aided to better beekeeping and enabled to combat disease with success. The making of one good beekeeper in a county may result ultimately in greatly increased wealth to the state, so that one cannot easily measure the economic value of such work. In spite of valid criticisms, and there is abundant

room for criticism in various states, we must conclude from such an examination that apiary inspection is economically sound and that the expenditure is warranted.

But, so far, the general approbation of the work has been based on just such general observations, without analyzing the situation carefully. It is now well, after twenty years of trial, to examine at least some of the available data to make the criticism more valuable. Such an examination cannot be made comparative because of the divergent systems just mentioned and often because of lack of available records. It is entirely just to conclude that where intelligible records are lacking the work is least valuable. To analyze all the available data is an enormous task, which cannot be undertaken at present, but a few specimens may stimulate the administrative offices in this work to apply this test, and it is hoped that the analyses will be published. These results should be announced, even though the results are not all that might be desired, and if possible the results should be interpreted. This is the type of comparison and tabulation which the author recommended to this section at the annual meeting in 1915.

In the Mohawk Valley, New York, European foulbrood broke out in 1894 but it was not until 1899 that apiary inspection was established, as a result of the efforts of the organized beekeepers. The inspectors made an effort to determine the loss in colonies actually destroyed by disease, and, while this record is probably incomplete, they found that colonies valued at $39,487 were reported as lost. In 1899 (the first year of inspection) and successive years to 1904, the loss of colonies that died was given in the 1904 report as follows:

| | |
|---|---|
| 1895–1899 | $39,487 |
| 1899 | 25,420 |
| 1900 | 20,289 |
| 1901 | 10,853 |
| 1902 | 5,860 |
| 1903 | 4,741 |
| 1904 | 2,220 |

When we consider the fact that in 1900 diseased colonies numbering 7,253 were found (valued at perhaps $40,000), it is evident that the disease was spreading with great rapidity and the State of New York made a good investment in establishing inspection whereby the percentage of diseased colonies was forced down from 23.9 in 1900 to 3.6 in 1905. About that time other outbreaks occurred but the per cent of colonies diseased has remained low.

Perhaps a better but less definite indication of the way in which, through inspection and education, the epidemic has been turned to the advantage of the beekeepers is in a comparison of past and present

conditions in the Mohawk Valley. It appears that before the outbreak of European foulbrood there were comparatively few extensive beekeepers in the valley and many uninformed and indifferent small holders. No inspection or educational system yet devised can save the careless beekeeper and it is unsafe to attempt too much along that line, but through the efforts of the inspectors and other educational sources, the careful beekeepers and those who would make an effort to clean up the disease were instructed in the diagnosis and treatment, so that today they have little fear of European foulbrood. There are probably fewer beekeepers than formerly but undoubtedly there are more colonies of bees and the average annual crop is larger than before the epidemic. The epidemic has thus been turned to an actual benefit to the industry through inspection.

In northwestern Indiana, European foulbrood is prevalent and has probably been present for many years. In the eastern portion of the state, American foulbrood is abundant and has caused enormous losses. On a brief trip of inspection, which the author took with Mr. George S. Demuth, then chief apiary inspector, but now in the Bureau of Entomology, several apiaries in the European foulbrood territory were found in which every colony was diseased.

In 1909 apiary inspection was instituted in Indiana under the supervision of the state entomologist. Of the 6,036 colonies examined that year 23.7 per cent were diseased and in Porter County 66.5 per cent of all colonies inspected had European foulbrood. The highest record for the prevalence of American foulbrood so far recorded is for Randolph County, Indiana, in 1910, where 83.5 per cent of the 3,000 colonies examined were diseased or dead.

To determine the results obtained through inspection, Mr. Demuth has kindly drawn up the accompanying table from part of the Indiana inspection records for the years 1909, 1910 and 1911, when he was doing the inspection. Counties were selected where inspection had been carried on in two successive seasons, and separate counts were made of those apiaries which were reinspected the second season. The revisited apiaries were usually those owned by beekeepers who, in the judgment of the inspector, were probably most in need of assistance and stimulation.

It may not be entirely clear why an entire county should show a decrease in the percentage of diseased colonies when only a part of the beekeepers had been visited, as was the case. This is doubtless due to the fact that the instructions of the inspector have been passed on to other beekeepers, indicating that the benefits of inspection are wider than might at first appear. It is also gratifying to see that in the reinspected apiaries there is usually a gain in the number of colonies amount-

TABLE OF INDIANA INSPECTIONS

| Indiana County | Total Inspection | | | | | | Apiaries reinspected successive years | | | | | | Prevailing disease |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Colonies examined | | Colonies found diseased | | Per cent of disease | | Colonies examined | | Colonies found diseased | | Per cent of disease | | |
| | 1909 | 1910 | 1909 | 1910 | 1909 | 1910 | 1909 | 1910 | 1909 | 1910 | 1909 | 1910 | |
| Cass | 87 | 13 | 38 | 1 | 43.9 | 7.7 | 15 | 15 | 3 | 0 | 33. | 0 | E. fb. |
| Daviess | 117 | 171 | 8 | 7 | 6.8 | 4.+ | 59 | 72 | 5 | 4 | 8.4 | 5.5 | E. fb. |
| Hancock | 33 | 54 | 25 | 12 | 75.7 | 22.2 | 0 | 0 | 0 | 0 | 0 | 0 | A. fb. |
| Jefferson | 256 | 250 | 71 | 13 | 27.7 | 5.2 | 165 | 168 | 57 | 12 | 34.5 | 7.1 | A. fb. |
| Lake | 270 | 130 | 163 | 22 | 60.3 | 19.6 | 104 | 66 | 87 | 8 | 83.6 | 12.1 | E. fb. |
| Marion | 189 | 197 | 42 | 3 | 22.2 | 1.5 | 70 | 73 | 27 | 3 | 38.5 | 4.1 | A. fb. |
| Newton | 209 | 83 | 68 | 18 | 32.5 | 21.8 | 33 | 13 | 30 | 12 | 93.7 | 92.3 | E. fb. |
| Pike | 66 | 60 | 20 | 8 | 30.3 | 11.5 | 63 | 33 | 20 | 5 | 31.7 | 15.4 | E. fb. |
| Porter | 508 | 687 | 348 | 265 | 66.5 | 38.5 | 428 | 470 | 305 | 184 | 71. | 39.1 | E. fb. |
| Jasper | 625 | 306[1] | 278 | 27[1] | 44.3 | 8.8[1] | 173 | 246[1] | 99 | 37[1] | 51.4 | 10.9[1] | E. fb. |
| Total | 2360 | 1960 | 1061 | 386 | 45. | 19.6+ | 1109 | 1156 | 633 | 265 | 57.+ | 22.9 | |
| **Dividing counties according to prevailing disease** | | | | | | | | | | | | | |
| E. fb. | 1882 | 1459 | 923 | 358 | 49.+ | 24.5 | 874 | 915 | 549 | 250 | 61.6 | 27.3 | |
| A. fb. | 478 | 501 | 138 | 28 | 28.8 | 5.5 | 235 | 241 | 84 | 15 | 35.7 | 6.2 | |

[1] No inspection was made in 1910 in Jasper County and the results of the work in 1911 are here given instead. Since the results are comparable the figures for this County are included in the totals.

ing to about 5 per cent in all. A decrease from 45 per cent to 19.6 per cent in one year is certainly a high commendation of the efficiency of the work.

In this state, not only is the percentage of diseased colonies being reduced, but the beekeepers are finding out what their trouble actually is and beekeeping conditions are rapidly improving. It will take strenuous and continued inspection and encouragement to put the business on the footing which it should occupy, but the short time so far spent in the work shows that here too the epidemics may ultimately be instrumental in making better beekeepers and thereby be an indirect benefit. In Randolph County, where 83.5 per cent of the colonies in 1910 showed American foulbrood, conditions have materially changed. The data are not at hand but Mr. D. W. Erbaugh is responsible for the statement that at present American foulbrood is scarce and the beekeepers in that territory are increasing their apiaries and are finding beekeeping profitable. This is the most striking result of the Indiana inspection, even though no work was done there between 1910 and 1916.

Through the courtesy of Mr. E. G. Carr of the New Jersey inspection service, I am able to give data concerning the percentage of infection in Salem, Cumberland and Cape May Counties, New Jersey, in 1913 and 1915.

| County | A. fb. 1913 | A. fb. 1915 | E. fb. 1913 | E. fb. 1915 |
|---|---|---|---|---|
| Salem | 3.3 | 0 | 5.9 | 2.5 |
| Cumberland | 0 | 0 | 16.9 | 10.1 |
| Cape May | 0 | 0 | 34.7 | 8.4 |
| Total | 1.4 | 0 | 16.7 | 6.2 |

It is interesting to note also that in this territory in 1913 there was European foulbrood in 30.2 per cent of all apiaries inspected and American foulbrood in 3.8 per cent. In 1915 no American foulbrood is recorded and European foulbrood was found in 25.9 per cent of the apiaries. Of course the per cent of apiaries showing disease cannot be decreased as rapidly as the per cent of infected colonies. During the two years the number of colonies increased from 836 to 1,136, a gain of 35 per cent, which is the true test of efficiency. The plan in New Jersey is to cover a county as completely as possible before leaving it.

In Connecticut in 1910 there were inspected 1,595 colonies, of which 49.6 per cent were diseased and disease was found in 76 per cent of the apiaries. Without giving the data for the intervening years, it may

simply be recorded that the records for 1916 show 3,808 colonies inspected, of which 7.05 per cent showed European foulbrood and 0.15 per cent showed American foulbrood. European foulbrood was found in 18.8 per cent of the apiaries and American foulbrood in 1.07 per cent.

Obviously, changes in inspection policy and the routine methods of the work will influence these figures. For example, in Connecticut inspection was formerly done only on complaint and this restriction has been removed. However, from the figures given for these four states there can be no doubt of the economic value of the apiary inspection.

It will be noticed that in the four states chosen the apiary inspection is under the supervision of a central office, in three cases that of the entomologist. In making a study of the available data to obtain material for this paper, the records were studied of a number of states where this supervision is lacking. In no such case did such a benefit appear as in the cases chosen. Usually the data are more faulty. There is not observed such a consistent gain, and in some cases no gain whatever is observed. Therefore, it must be admitted that the instances chosen are not truly representative. It is not known whether the best records have been chosen, but they are certainly among the best. The data must therefore be interpreted as showing what can be done under good management. Every effort should be made to improve the inspection service in some of the states and this can, perhaps, best be done by publication of the results of inspection, as was recommended at the last meeting of this section. The inspection must also be improved by dicontinuing, so far as possible, the payment of inspectors only for days spent in the work, which too often means for days when they are not otherwise occupied.

The title chosen for this paper may be assumed to be covered by the type of data given, but at this opportunity it may be well to enlarge the discussion by way of pointing out a method of overcoming some present defects. As is well known, the Bureau of Entomology has during the year begun extension work in beekeeping, in coöperation with the regular extension offices. So far this work is confined to the Southern States. When it is considered that the value of inspection comes chiefly from the efficiency of the educational feature of the work, it will be seen that, in a sense, extension work is but a continuation of what has been done for years in some states. However, an extension worker is freed from the odium of police power, which is at times a detriment to the inspection work. Since in perhaps half the states the apiary inspection is below its possible efficiency, and, since without unwarranted interference this cannot well be changed, except by the

beekeepers of the state who often fail to recognize the poor quality of the work, it is pertinent to suggest that extension work should replace at least the incompetent inspection, or, if it is possible, supplement and stimulate it.

The future of the beekeeping industry depends in no small measure on the creation of professional beekeepers. Apiary inspection was instituted chiefly to save what already existed and was not conceived as a creative agency. If inspection is to assist in giving the much needed impetus to the industry, every apiary inspector should emphasize the extension features of his work, so far as his authority will permit, and in addition should encourage and support the extension work which openly assumes the task so long carried unannounced by the inspection. By enlarging the extension work to the fullest extent we may expect still more satisfying results than those here tabulated.

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## Section on Horticultural Inspection

The Fifteenth Annual Meeting of the Section on Horticultural Inspection was held in New York City on December 27 and December 29, 1916, respectively.

Fortunately, a "joint session" of the American Phytopathological Society and the American Association of Economic Entomologists was arranged for Wednesday, December 27, 1916, at 9.30 a. m. in Barnard College, for a conference on two dangerous imported plant diseases which have become established in the United States, and are assuming threatening proportions, viz., the citrus canker and the white pine blister rust. This "joint session" proved so profitable and interesting that an attempt will be made at future meetings to arrange for at least one "joint session," for the consideration and discussion of new insect pests and plant diseases. The entomologists and horticultural inspectors present at this meeting received the very latest advice concerning important phases of these diseases, their development, the rapidity and possibility of spread and possible methods of control and eradication.

An invitation to attend the sessions was extended to the legislative committee of the National Nurserymen's Association and to Mr. Curtis Nye Smith, of Boston, Mass., Secretary and Counsel of this Association. Mr. William Pitkin, of Rochester, N. Y., chairman of the legislative committee; Mr. J. M. Pitkin, of Newark, N. Y.; Mr. J. H. Dayton, of Painesville, O., attended the sessions and conferences.

## PROGRAM

### JOINT SESSION

American Phytopathological Society.
American Association of Economic Entomologists.
Section on Horticultural Inspection.

## CONFERENCE ON PHYTOPATHOLOGICAL INSPECTION AND QUARANTINES

*Wednesday, December 27, 1916, 9.30 a. m., Room 139, Barnard College*

Aims and Methods of Pathological Inspection—F. R. Lyman, Washington, D. C.

New Foreign Pathological Quarantines and Restrictions—R. K. Beattie, Washington, D. C.

Citrus Canker Investigations at the Florida Tropical Laboratory—R. A. Jehle, Miami, Fla.

The Present Status of Citrus Canker Eradication—K. F. Kellerman, Washington, D. C.

The Present Status of White Pine Blister Rust in North America—Haven Metcalf, Washington, D. C.

Evidence of the Over Wintering of *Cronartium ribicola*—Perley Spaulding, Washington, D. C.

The Control of White Pine Blister Rust in Small Areas—W. H. Rankin, Geneva, N. Y.

The Committee for the Suppression of White Pine Blister Rust in North America: —Purpose, Personnel and Program—J. G. Sanders, Harrisburg, Pa.

### SECOND SESSION

*Friday, December 29, 1916, 2.00 p. m., Teachers' College*

Business—Election of Chairman and Secretary for 1917

1. The Weakness of our Present System of Inspection of Foreign Shipments—W. J. Schoene, Blacksburg, Va.

2. Activities of the Federal Horticultural Board at the Port of New York—Harry B. Shaw, In Charge of New York Port Inspection.

3. Important Foreign Insect Pests Collected on Imported Nursery Stock in 1916—E. R. Sasscer, Washington, D. C.

4. The State Entomologist's Work with Pine Blister Canker in Minnesota—F. L. Washburn, Minneapolis, Minn.

5. Potato Inspection in Minnesota—F. L. Washburn, Minneapolis, Minn.

6. Discussion—How Are We Aiding Nurserymen by Enforcing Sanitation of Adjacent Premises?

Reports of Methods Employed in Various States.

### THIRD SESSION

*Friday, 8.00 p. m., American Museum of Natural History*

A Symposium on Existing State Horticultural Inspection Laws.

An Open Round Table Discussion—Led by Mr. William Pitkin, Rochester, N. Y., Chairman legislative committee, American Association of Nurserymen, and Mr. Curtis Nye Smith, Boston, Mass.—Counsel and Secretary, American Association of Nurserymen.

### Second Session

The second session of this Section was called to order in Teachers' College, at 2.15 p. m., Friday, by Dr. W. E. Britton, who was elected chairman *pro tem.*, in the absence of Prof. W. J. Schoene. After a short business session Prof. G. M. Bentley, Knoxville, Tenn., was elected chairman for 1917, and Prof. J. G. Sanders, Harrisburg, Pa., was reëlected secretary. By official action the name of the body was changed from the original title—"The American Association of Official Horticultural Inspectors"; and the title, "Section of Horticultural Inspection" of the American Association of Economic Entomologists was adopted for future use.

### Third Session

The third session of this Section was held in the American Museum of Natural History on Friday, December 29, at 8 p. m. This meeting was a radical departure from anything previously held, in that it was turned over to the representatives of the National Nurserymen's Association present at the meeting.

Mr. William Pitkin, of Rochester, N. Y., opened the meeting with a short resumé of the remarkable and happy advances which have been made in horticultural legislation, and in the better mutual understanding of the problems of the nurserymen and the inspectors. During the last five or six years, he said, through several conferences and official meetings many knotty problems had been threshed out, pertaining to nursery inspection and the handling of nursery stock. He spoke in a very happy vein of the more candid relationship which had been generated in the nurserymen and inspectors by these occasional meetings, and hoped that the future would bring about even more satisfactory results. Mr. Pitkin thanked the inspectors on behalf of the Nurserymen's Association for the invitations and privileges which have been extended to them.

At this point Mr. Pitkin gave way to Mr. Curtis Nye Smith, secretary and counsel of the American Association of Nurserymen, who opened the discussion on "Some Existing State Horticultural Inspection Laws" from a standpoint of legality and constitutionality. Mr. Smith's clear and concise statements and explanations concerning the legal phases of horticultural inspection laws were indeed educational, and served to clarify a number of rather intricate legal problems in horticultural inspection.

Hearty discussions were engendered, and much information was brought forth regarding the requirements of certain states in their horticultural laws, which from a legal standpoint seemed to be unconstitutional and confiscatory in nature.

Mr. Smith discussed at some length what consummated a "sale," and where and when the sale of stock was completed, the order for which had been taken by an agent in another state. It is unfortunate that a larger number of our horticultural inspectors of the country could not have been in attendance at this session.

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## THE COMMITTEE FOR THE SUPPRESSION OF PINE BLISTER IN NORTH AMERICA: PURPOSE, PERSONNEL AND PROGRAM

By J. G. Sanders, *Harrisburg, Pa.*

The recent formation of an enlarged unofficial committee for the purpose of uniting the efforts of the various states and Dominion Provinces with the Federal and Dominion Governments to control and prevent the further dissemination of the dangerous blister canker, which threatens to wipe out the white pine industry of the North American Continent, is a most praiseworthy effort.

It is not necessary at this time to review fully the past history of this committee, but it is well to note that the movement originated in Massachusetts, where the extremely dangerous nature of the disease was first observed in its destructive stages. Officials of the Massachusetts Forestry Association,—particularly Mr. Harris A. Reynolds and Mr. William P. Wharton of Boston—have been largely instrumental in continuing this effort, which has now resulted in a nation-wide movement.

On November 20 and 21 this year, on invitation, this committee, with several additional state officers invited, met at Albany, N. Y., and appointed committees for the consideration of questions which immediately arose. Reports from various states where infections had been found were received, and the infected areas graphically illustrated by maps and charts. There is no doubt but that these reports revealed an alarming condition in the eastern United States, and the consensus of opinion at the meeting was that immediate, powerful and drastic efforts should be made before another summer, to safeguard the western pine interests, and to control the disease in the eastern United States where infections occur.

Scouting on a very much greater scale was deemed advisable, the burden of this work, however, is to be undertaken by the Federal Government; the clean-up and follow-up work to be performed largely by the state officials in coöperation with the Federal Department.

Resolutions dealing with various questions of control and eradication were adopted, the most important, however, being the promulgation of

two bills in the United States Congress. It was thought advisable that a bill be immediately introduced and passed during the coming session, if possible, absolutely prohibiting the shipment of 5-leafed pines and all species of Ribes beyond the quarantine line, which should be indicated as the western border of Minnesota, Iowa, Missouri, Arkansas and Louisiana, and that in enforcing this quarantine the Dominion Government would coöperate to the mutual advantage of each government.

A second bill which was deemed advisable for passage is one in which the Federal Government is to prohibit the importation of all nursery stock as defined under the present rules and regulations of the Federal Horticultural Board, except that the Department of Agriculture may import, grow and propagate, under proper quarantine conditions, for experimental and scientific purposes, such nursery stock that is deemed desirable by said department. Bills for these purposes are to be given further consideration and discussion at the annual meeting of the American Forestry Association in Washington, D. C., January 18–19.

An indication of what the enlarged committee may succeed in doing is the success attending the efforts of the original committee in securing $50,000 from the Federal Congress to promote the work during the past year. It is reasonable to believe that with the coöperation of all the members of this enlarged committee much more efficient work may be carried on, with a very much increased appropriation. Naturally, the campaigning efforts of the committee will lend weight to argument in the state legislatures for support, and in this way much mutual assistance may be had.

The personnel of the enlarged committee has been determined by resolutions, which were adopted, allowing not to exceed four members from each state and Canadian province where white pine is growing. These four members in the various states were to be appointed from six sources deemed most advisable, viz., the state forestry association, a lumbermen's association, state department of agriculture, the agricultural experiment station, the agricultural college and the officer having charge of the enforcement of the horticultural inspection laws. From these sources it was thought that four very efficient and deeply interested representatives could be appointed for this enlarged international committee. The selection of these officials is underway at this time, and the complete personnel of the committee will doubtless be announced shortly.

An executive committee of three was selected at the Albany meeting, and consists of Mr. William P. Wharton of Boston, chairman, E. C. Hirst, state forester of New Hampshire and J. G. Sanders, economic zoölogist of Pennsylvania.

The program of the committee has been outlined in a degree, but

the most important matter which must be taken up immediately by the several state committee members, is the passage by the legislatures of horticultural inspection laws of sufficient and inclusive power to permit the official in charge to proceed with all necessary speed to check this disease. Sufficient funds should be secured in order to coöperate fully with the Federal Department and follow up their scouting work in the suspected districts. The time for immediate action is here, and I can not impress upon the members of that committee too strongly the importance of taking this matter to heart, and acting upon it before another summer has elapsed. The experience of last summer, in which the disease was spread broadcast—in some cases, as far as we can judge, advancing several miles in all directions from infected localities—is sufficient warning to the thoughtful scientists and officials.

All the energy, influence and power which the members of this committee have at their command should be exercised in assisting in the passage of the bills previously mentioned through our Federal Congress. Furthermore, it is necessary that the members of this committee exert their influence and extend their moral support to the Federal Horticultural Board, in their campaign for the control of import shipments and the establishment of quarantines. It is believed that if the Federal Board fully realized the feeling of the officials and citizens of a larger number of our middle and western states, they might take more drastic action upon certain fundamental questions than they have in the past. Unfortunately, our state officials and inspectors have not been so careful to appear before the Federal Board hearings as have the members of the nurserymen associations and the brokers, to express their views on horticultural matters. Consequently, the Federal Board has had the burden of testimony oftentimes on the side which has not appeared entirely satisfactory to our state officials.

It now remains for the members of this board, who have been honored by selection and appointment, to coöperate fully with the executive committee, chairman and secretary, so that the best result may be quickly secured.

We are most happy in knowing that the American Forestry Association have promised to assume all expense and responsibility in pushing the publicity campaign without which we will be almost helpless. This Association, through its president, Mr. Charles Lathrop Pack, of New York, and Mr. P. S. Ridsdale, editor of *American Forestry*, Washington, D. C., promises its efforts in promulgating the desired legislation in the Federal Congress, and also its assistance wherever possible and desirable in state legislation.

As one of the executive members of this committee I wish to express our keen appreciation of the kindness of the American Forestry Association in this campaign.

# THE WEAKNESS OF OUR PRESENT SYSTEM OF INSPECTION WITH REGARD TO FOREIGN SHIPMENTS

By W. J. Schoene, *Blacksburg, Va.*

These remarks are not intended to apply to conditions in any one state, but rather to the whole country, and to refer more especially to past events and future happenings. Owing to the peculiar dual form of our government, each state has authority, so far as injurious pests are concerned, to regulate or not to regulate its internal affairs in any way its citizens may desire; and entomologists, who have been laboring for the development of our inspection work and the enactment of crop pest legislation, have always had this fact to contend with; for, as we are fully aware, state lines do not function as barriers to the spread of injurious pests. The policy of one state has frequently been radically different from its neighbor. One state may promulgate stringent rules to control or to suppress an injurious pest, while other states may either refuse to act or else adopt the policy of letting nature take its course. The result of such policy, so far as the spread of injurious pests are concerned, is obvious.

As a specific instance of the condition just mentioned, there are certain states, which some years ago were believed to be free of San José scale, and which provided themselves with adequate inspection machinery to protect their fruit industry; while in other states in which the presence of this insect was a matter of common knowledge, only scant appropriations were made for inspection work; or, as has happened, the best horticultural authorities actually opposed inspection legislation.

As history repeats itself, so the history of the spread of the San José scale and of the attending diversity of laws will be repeated, in modified form, with the appearance of each important pest. Take, for instance, the white pine blister rust, authorities are by no means agreed either as to the best means of handling the problem or what the situation demands.

In considering the inspection of foreign shipments of plants, which is certainly the most important problem confronting American entomologists today, we find some diversity of opinion. This is especially true when we compare the ideas of the importer or the buyer with those held by some of our entomologists. The importer, as well as the buyer, looks upon the trade in foreign stocks as an ordinary commercial proposition and a large business has been built up in this class of goods because ornamental and fruit stocks can be produced cheaper, and perhaps better, abroad. This traffic is being continued, in spite of the protest of a few entomologists, although the United States is the only great nation that opens its doors to almost unlimited importations of

living plants. The danger is recognized, but entomologists are not entirely of one accord and, doubtless, the officials of the Federal Horticultural Board could tell us that the inspection of importations of stock is considered a much more serious matter in some states than in others.

Another unquestioned obstacle to the successful prosecution of inspection work in America, as well as greater restriction of foreign shipments, is the interference by persons having legislative authority. There is probably no state in which inspection officials have not at one time or another felt such influence. The writer had occasion to attend a meeting called by the Federal Horticultural Board to discuss a domestic quarantine. At this meeting there were several congressmen present representing the districts in question, and the writer understands that this is not unusual. Whether or not the members of the Federal Board have ever been embarrassed by representative congressmen, of course, can be answered only by members of the board. However, it may be asserted positively that the powerful nursery interests of this couutry are thoroughly organized and always ready to maintain a lobby to protect their interests.

Then, to conclude, we have on the North American continent, Canada, Mexico, and the states and territories comprising the United States, fifty or more sovereign powers; each making its own laws, each law different and each inspection official with a different idea. And yet, there are no natural barriers to limit the spread of an injurious species, transportation lines of one sort or another touch every part of the continent; and once established, it is only a question of time until every disease or insect will reach the remote parts of the continent in spite of all quarantines and restrictions imposed.

Because of the peculiar organization of our government, and the powerful commercial interests that are able to influence legislation, inspection officials should band themselves together and act as an organization for the purpose of securing more stringent regulations regarding the importation of plants from foreign countries and greater uniformity in the treatment of our domestic problems.

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## THE ACTIVITIES OF THE FEDERAL HORTICULTURAL BOARD AT THE PORT OF NEW YORK

By Harry B. Shaw, *New York, N. Y.*

(*Abstract*)

The activities of the Federal Horticultural Board at the Port of New York are for the most part connected with the practical application of the provisions of the Plant Quarantine Act to the quarantines in force. With few exceptions contact is made at this port with all current plant quarantines.

The secretary of agriculture and the secretary of the treasury, by the provision of the Quarantine Act, coöperate through the custom service in notifications of receipt of plants from abroad. This extensive coöperation involves directly or indirectly nearly 3,000 customs employees.

The writer, appointed in April, 1914, as representative of the Federal Board at this port, has been in close association with the custom service, and has learned the various avenues of receipt and the methods of guarding the various importations. Entry clerks scrutinize the invoices and records and number the entries and assess the duties. In the case of imported plants the entry clerks require the importer to furnish certificate of inspection from the country of origin. Irregularities, such as lack of certificates of inspection and permits, are referred by the entry clerks to the pathological inspector for instructions. All entry of nursery stock from countries not listed as operating an inspection service are opened at the docks, or in public stores, for immediate inspection.

Through the instrumentality of delivery permits and the custom inspectors we are able to prevent the release of nursery stock until all requirements have been met.

Small personal importations of nursery stock are handled through the appraiser, and are examined after having received notification from this officer. Frequently plants which are brought in as baggage by passengers arriving from all parts of the world are discovered, and inspected by authority of the surveyor of the port. Notices in printed form for distribution to passengers, warning them concerning the importation of living plants, have been distributed, and these doubtless will soon reduce the number of importations by passengers.

Importations of potatoes entering this port in 1913–14 were inspected to ascertain the presence of powdery scab and potato wart disease. These arrived by the thousands of sacks and crates from Holland, Belgium, Denmark and Sweden. Powdery scab was discovered in numerous shipments, as well as an abundance of the more common potato diseases. No evidence of potato wart, however, was discovered.

Since the outbreak of the European War the importation of potatoes has entirely ceased. In the meantime powdery scab was discovered in Maine, and Quarantine No. 14 was issued, prohibiting the movement of potatoes from that state excepting after Federal certification.

Attempts were made to ship potatoes from United States ports to Cuba and other West Indian points, and also to South America. Carelessness in selection of potatoes caused their arrival in some cases at points of destination in very poor condition, and our markets were thereby injured.

The inspection of cotton from foreign countries, on account of the pink boll worm danger was originally carried on at the dock, but after thorough fumigation became obligatory the dock inspection has been discontinued, and reliance has been placed on the thorough fumigation in large chambers which have been constructed by importing companies. Large quantities of old gunny sacks, burlaps and hessian, as well as much jute waste and shoddy wrapped in old cotton bale covers are imported. This fact being demonstrated the Board required that all burlaps, which had been used for covering cotton, should be treated before release.

Special disinfection plants have been erected to meet the requirements of the Federal Board, so that large importing companies now handle an immense quantity of material in a day. One company has erected two fumigating chambers of cylindrical form, 9 feet in diameter and 116 feet long, through which pass in a single day a large number of bales of imported cotton and other cotton waste materials.

In addition to the port of entry inspection other phases of activity, such as inspection of samplerooms and receptacles for storage of cotton samples, inspection of warehouses, factories and storerooms in New York and its vicinity have been carried out, in order to meet the requirements of the Federal Board attempting to prevent the introduction of dangerous insects and diseases.

(Numerous interesting lantern slides showing the New York port of entry, the large cargoes of various material to be inspected, the fumigation chambers and plants of certain firms and the inspection of potatoes, were thrown on the screen.)

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## IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1916

By E. R. SASSCER, *Washington, D. C.*

The fiscal year 1916 marked a slight decrease in the amount of nursery stock offered for entry by the five principal European countries exporting plants to the United States with the exception of Holland. Although the amount of nursery stock exported by Belgium, England, France, and Germany into the States during this period is somewhat less than in the fiscal years preceding, it will be noted from the table below that more plants were imported from these countries, except Germany, in 1916, than in 1913 or 1914.

As the result of State and Federal inspection the following insects have been intercepted during the calendar year: Egg masses of the gipsy moth (*Porthetria dispar* Linn.) were taken on five different occasions as follows: on beech and apple stock from France, on

TABLE SHOWING AMOUNT OF NURSERY STOCK OFFERED FOR ENTRY DURING THE PAST FOUR YEARS

| | 1913 | | 1914 | | 1915 | | 1916 | |
|---|---|---|---|---|---|---|---|---|
| | Nursery Stock | Seed, Pounds | Nursery Stock | Seed, Pounds | Nursery Stock | Seed, Pounds | Nursery Stock | Seed, Pounds |
| Belgium..... | 704,927 | | 720,891 | 165,000 | 1,114,089 | | 1,065,564 | 20 |
| England..... | 2,573,174 | | 2,267,295 | | 3,914,901 | | 2,872,745 | 5,625 |
| France..... | 30,812,089 | | 29,024,187 | 2,073 | 41,604,161 | 40,053½ | 38,202,978 | 30,210 |
| Germany..... | 1,360,296 | 7,030 | 194,186 | 1,049 | 177,994 | 821½ | | 82 |
| Holland..... | 5,274,944 | | 4,602,954 | | 6,539,416 | 6 | 9,562,421 | |

*Thuya* and *Azalea* from Japan, and on rose from Holland. Nests of the brown-tail moth (*Euproctis chrysorrhœa* Linn.) were collected on five consignments from France. Egg masses of the European tussock moth (*Notolophus antiqua* Linn.) were repeatedly collected on stock from France and Holland, and pupæ of a dagger moth (*Apatela auricoma* Fab.) were reported on five shipments from France and one from Holland. *Gracilaria zachrysa* Meyrick has been frequently reported on azaleas from Holland, Belgium, and Japan. *Porthesia similis* Fuessly, a close relative of the brown-tail moth, was collected on rose in Georgia from Holland. The larvæ of this moth are found in small hibernaculæ and may be easily overlooked. This insect has a wide distribution in Europe, and has also been reported from China, Japan, and Korea. The Leopard Moth (*Zeuzera pyrina* Linn.) was collected in Ohio on Paradise apple stock from France. Dead larvæ of the pink boll worm (*Gelechia gossypiella* Saunders) were found in samples of China cotton enclosed in glass trays exhibited at the Panama-Pacific Exposition at San Francisco. Although every precaution was taken to safeguard this material by the California authorities, the finding of these dead larvæ forcibly demonstrates the possibility of introducing new and injurious pests in plant products exhibited at expositions.

In this connection it is of peculiar interest to note that the prize ship *Appam*, which was brought into Hampton Roads early in the year, contained as a part of its cargo some two hundred tons of cotton seed from Lagos, West Africa, a region known to harbor the pink boll worm. Although no living larvæ of the pink boll worm were located it was apparent, from the condition of the material, that about 2 per cent of the seed had at one time been infested with this insect. To safeguard the cotton interests of this country the entire consignment was converted into fertilizer by a Portsmouth firm, and the dock on which the seed had been unloaded was thoroughly cleaned and the ship fumigated with hydrocyanic-acid gas. The arrival of a quarantined product on a prize ship opens up a new avenue of entrance, and

had not the customs officials at Norfolk been familiar with the cotton regulations this consignment could have been officially entered, and in all probability would have received a wide distribution.

The mango weevil (*Sternochetus mangiferæ* (Fab.) ), *Cryptorhynchus*, was collected in mango seed from Siam and Japan, and larvæ of what appears to be a new species of *Conotrachelus* were collected in avocado seed from Guatemala. *Prunus* seed from Japan received in Washington exhibited injury made by a species of *Anthonomus* closely related to *druparium*. Several dead adults and larvæ were taken. A pine prop used to support nursery stock in a container was found to exhibit galleries made by *Tomicus piniperda* Linn., one of the more destructive insect enemies of the pine in Europe. When received, many adults had emerged, and it is impossible to say whether they emerged before leaving Holland or after arriving in the States. Cocoons of a sawfly, *Emphytus cinctus* Linn., were intercepted on green ash cross sticks or props from England and on Manetti stock from France. Orchids from Venezuela and Colombia were frequently found to be infested with *Tenthecoris bicolor* (Scott). *Lachnus fasciatus* Burm. was collected on *Picea glauca* from France, and *Lachnus hyalinus* Koch was collected on *Picea excelsa* from France. An unrecognized species of *Lachnus* was collected on *Juniperus virginiana* from France. The box psyllid (*Psylla buxi* Linn.) was reported on thirty-three shipments of boxwood from Holland, and a white fly, *Aleurothrixus* sp., was taken on "Semilla de Molle" from Chile. Coccids have been reported on numerous occasions, some of the more important of which are the following:[1]

*Aspidiotus tsugæ* Marlatt on hemlock from Japan.
*Aspidiotus subsimilis* Ckll. on avocado from Guatemala.
*Aspidiotus palmæ* Morg. and Ckll. on cocoanut from Honduras.
*Chrysomphalus personatus* Comst. on orchid from Canal Zone.
*Chrysomphalus perseæ* Comst. on orchid from Mexico, Venezuela, Canal Zone, Colombia, and Panama.
*Pseudaonidia articulatus* (Morg.) on *Areca* sp. from Trinidad.
*Pseudaonidia articulatus* (Morg.) on cinnamon from Jamaica.
*Pseudaonidia paoniæ* (Ckll.) on azalea, persimmon, camellia, and rhododendron from Japan.
*Pseudaonidia duplex* (Ckll.) on camellia from Japan.
*Targionia biformis* (Ckll.) on orchid from Canal Zone, Colombia, and Guatemala.
*Targionia sacchari* (Ckll.) on sugar cane from Antigua, B. W. I., and Cuba.
*Pseudischnaspis bowreyi* (Ckll.) on *Agave Wightii* from Jamaica.
*Chionaspis wistariæ* Cooley on wistaria from Japan.
*Chionaspis* sp. on chayote from Jamaica.
*Epidiaspis piricola* (Del G.) on apple (2) from France.
*Lepidosaphes lasianthi* (Green) on camellia (3) from Japan.
*Lepidosaphes newsteadii* (Sulc.) on umbrella pines (2) from Japan.

[1] The number in parentheses following name of host indicate the number of times reported.

*Lepidosaphes mimosarum* (Ckll.) on *Anona cherimoya* from Guatemala.
*Lepidosaphes* sp. on *Agave* from Panama.
*Lepidosaphes* sp. on croton from Costa Rica (3).
*Parlatoria chinensis* (Marlatt) on flowering shrub from northern China.
*Parlatoria crotonis* (Douglas) on croton from Costa Rica.
*Parlatoria calianthina* (Berl. & Leon.) on olive from Greece.
*Pinnaspis buxi* (Bouché) on *Dracæna* from Jamaica.
*Pseudoparlatoria parlatorioides* (Comst.) on orchid from Brasil.
*Conchaspis angraeci* (Ckll.) on orchid from Canal Zone.
*Antonina crawii* (Ckll.) on *Bambusa nigra* from Japan.
*Asterolecanium aureum* (Bdv.) on orchid from Isle of Pines and Canal Zone.
*Eriococcus coccineus* (Ckll.) on Echinocactus from Peru.
*Lecanium bituberculatum* (Targ.) on *Malus* sp. from Holland.
*Orthezia cataphracta* (Shaw) on *Iris setosa* from Newfoundland.
*Pseudococcus bromeliæ* (Bouché) on pineapple (3) from Trinidad.
*Pseudococcus marchalii* on *Mangifera indica* from Calcutta, India.
*Pseudococcus sacchari* (Ckll.) on sugar cane from Hawaii.
*Pulvinaria pyriformis* (Ckll.) on cinnamon from Jamaica.

In addition to the above, many insects of greater or less importance have been taken on various plants and plant products. All interceptions are listed in Letters of Information issued by the Federal Horticultural Board, and these letters are available to all inspectors.

The following list indicates, by countries, the number of species of insects reported by State and Federal inspectors during the calendar year 1916 up to and including December 16:

| | | | |
|---|---|---|---|
| Holland | 68 | Straits Settlements | 4 |
| Colombia | 51 | Arabia | 3 |
| Japan | 37 | Greece | 3 |
| France | 36 | Madagascar | 3 |
| Belgium | 25 | New Zealand | 3 |
| England | 24 | Panama | 3 |
| Brazil | 20 | Russia | 3 |
| Cuba | 19 | Trinidad | 3 |
| Jamaica | 12 | Antigua, B. W. I. | 2 |
| Canal Zone | 11 | Bahama Islands | 2 |
| China | 11 | Eritrea, Africa | 2 |
| Venezuela | 11 | Guadeloupe, French W. I. | 2 |
| Guatemala | 8 | Haiti | 2 |
| India | 8 | Hawaii | 2 |
| Philippine Islands | 8 | Honduras | 2 |
| Bermuda | 7 | Newfoundland | 2 |
| Chile | 7 | Northern Nigeria | 2 |
| Costa Rica | 7 | Peru | 2 |
| Italy | 7 | Spain | 2 |
| Mexico | 7 | Turkey | 2 |
| Egypt | 6 | Argentina | 1 |
| Scotland | 5 | Azores | 1 |
| Australia | 4 | Canada | 1 |
| British Guiana | 4 | Ecuador | 1 |

| | | | |
|---|---|---|---|
| Isle of Pines | 1 | Senegal | 1 |
| Java | 1 | Seychelles | 1 |
| Natal | 1 | Siam | 1 |
| Paraguay | 1 | Sudan | 1 |
| Portugal | 1 | Turk's Islands | 1 |
| Santo Domingo | 1 | | |

## APHID EGGS IN TEXAS (Lat. 30°, 30')

By HAL C. YINGLING, *College Station, Texas*

For some time the impression has existed that oviparous reproduction in aphids does not occur in the extreme southern portion of the United States. To quote F. M. Webster (Bureau of Ent. Bul. No. 110),—"In the South, seemingly south of about latitude 35° to 36° north, it has been impossible to find eggs of this (*Toxoptera graminum* Rond.) and other species of aphidids in the fields." Other papers have given the same impression, apparently based on the fact that no eggs had been found and the assumption that the egg stage was unnecessary for hibernation in warmer climates. As practically all of Texas lies south of 35°, the common impression has been that aphid eggs do not occur except in the northern part of the state.

On a collecting trip December 16, 1916, the writer found two rather large clusters of aphid eggs with wingless aphids in the act of oviposition, all under normal conditions for the locality. The eggs were packed closely together upon a single stem of dogwood (*Cornus asperifolia* Mich.), the two clusters being situated near the end of the twig, about three inches apart. Wingless females alone were found, huddled together on and around the masses of eggs, the weather being rather chilly.

The material was turned over to Prof. F. B. Paddock of the Texas Agricultural Experiment Station, who identified the aphid and host, also making a brief study of the habits. The aphid compares very favorably with the description of *Schizoneura corni* Fab.

Professor Paddock had the good fortune to watch the deposition of an egg by one of the females, the process being resumed when the aphids were introduced into the warm laboratory. The female backed up to the egg cluster to place the egg with the others, the whole process taking about forty-five minutes for completion. During this time the middle legs were held tightly folded under the body. The egg was deposited with its long axis perpendicular to the surface of the bark, but soon turned over and rested in a horizontal position. The material covering the egg was viscous enough to enable the aphid to use the egg as an anchor while placing the next egg.

When first deposited, the egg was a deep cherry-red, becoming dark brown in about fifteen minutes. Nearly an hour was required for the complete assumption of the black color. At the time of writing, the smaller cluster contains about one hundred eggs, while the larger one exceeds two hundred in number, the process of oviposition not being completed as yet.

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## Scientific Notes

**Notes on Several Insects not Heretofore Recorded from New Jersey.** *Janus obbreviatus* Say[1] (Hymen.). This saw-fly appears to be established at the following localities in New Jersey; Bound Brook, Rutherford, Irvington, Elizabeth, South Orange and Springfield, occurring as a rule in nurseries. The larvæ live in the twigs of poplar and willow trees and are generally found in those which spring from the base of the tree. Occasionally twigs higher up are infested. After the middle of summer, the infestation is readily noticed by the dying back and turning black of the tips of the shoots. At the present time, in New Jersey at least, it is more of a nursery than a shade tree pest.

*Diprion simile* Hartig (Hymen.). This species, known as the European pine saw-fly was found for the first time in New Jersey during the summer of 1916 at the following localities: Elizabeth, Rutherford, South Orange, and like the preceding species, its activities were confined entirely to pine trees in nurseries. It has evidently been present in New Jersey for the past several years and during the past season was rather heavily parasitised inasmuch as from two hundred cocoons, only eighteen adults were secured, the remainder bringing forth hundreds of specimens of *Monodontomerus dentipes* Boh.[2] In the June, 1915, number of the JOURNAL OF ECONOMIC ENTOMOLOGY, p. 379, there appeared a paper on this saw-fly by Dr. W. E. Britton.

*Phytomyza aquilegiæ* Hardy (Dip.). In some way or another, this species known commonly as the columbine leaf-miner, was omitted from Smith's List of the Insects of New Jersey. As a matter of fact, it is a local pest of columbine and has been noted at Springfield, Rutherford, Riverton and Elizabeth and undoubtedly has a much wider distribution. Mr. E. N. Cory in his paper on this species (JOUR. ECON. ENT., vol. 29, No. 4, pp. 419–424) also mentions New Brunswick, which is an additional locality. The destruction of the infested leaves early in the season where practiced in New Jersey has been followed as a rule by a considerable lessening of the injury later in the season.

*Blaberus discoidalis* Serv. (Orthop.). This large attractive roach has been found several times in greenhouses in New Jersey, having been introduced with orchids imported from South America. According to Mr. Morgan Hebard, who identified this species, it is one of the commonest members of the genus through the West Indies, northeastern South America and as far northward on the mainland as Panama. Mr. Hebard treats of this species in his paper "Critical Notes on Certain Species of the Genus Blaberus," published in *Entomological News*, vol. 27, No. 7, pp. 289–296.

HARRY B. WEISS, *New Brunswick, N. J.*

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[1] Identified by S. A. Rowher.

[2] Identity obtained from Mr. Crawford through Dr. W. E. Britton.

**The Clover Weevil in Iowa.** The following note on *Hypera punctata* in Iowa may be of interest taken in connection with the recent records of James W. McCollough (JOUR. ECON. ENT. vol. 9, p. 455) in Kansas.

So far as I know the first record of this species in Iowa is a previous record of my own (JOUR. ECON. ENT., vol. 3, p. 502) which reports its occurrence at Burlington in April, 1910. A year or two later Prof. H. F. Wickham collected it at Iowa City, although I believe no published record has been made of this. The insect was not brought to my attention in Iowa again until November, 1914, when I observed larvæ at Mount Pleasant, Iowa, about thirty miles west of Burlington, November 12. Two days later larvæ were seen feeding on clover at Davenport.

April 8, 1915, larvæ were observed fairly common on clover at Clarinda in southwestern Iowa. This was the first record in the western part of the state. April 21, 1915, I found it at Ames, in central Iowa; May 10 on alfalfa at Council Bluffs in extreme western Iowa; May 11 on alfalfa at Red Oak in Southwestern Iowa.

In northeastern Iowa larvæ were again observed on clover, May 11 and 12, 1916, at Dubuque, Bellevue and Cascade; nearby localities.

From these records it is likely that the insect occurs all through southern Iowa and probably most of eastern Iowa.

R. L. WEBSTER.

**Pink Boll Worm.** November 1 specimens of cotton bolls showing the presence of *Gelechia gossypiella* were received at the Bureau of Entomology. They came from San Pedro de las Colonias, Mexico. This was the first record of the occurrence of this important pest in America. Investigation indicates that it was introduced into Mexico through Egyptian seed imported for experimental purposes. The first step taken to protect the country against this pest was an absolute quarantine on Mexican cotton seed and bales of lint, which became effective on November 4. All shipments of Mexican cotton seed which have entered the country since July 1 have been traced to their destinations and strong efforts are being made in coöperation with state officers and the Texas Cottonseed Crusher's Association to have it crushed without delay. A somewhat reassuring feature of the situation is that the great bulk of the seed imported was more than one year old and could not have carried any infestation. It will be necessary, however, to make very frequent inspections in Texas next season and to be prepared to stamp out any colonies which may have become established. In the meantime, if possible, a thorough exploration may be made in Mexico. Messrs. Hunter, T. C. Barber, Loftin, Dove, and Bishopp were engaged in work connected with this emergency during November. The outbreak in the Lagune District of Mexico is probably of two or three years' standing, but has probably only begun extensive spread in this district during the last year, and no instance of actual infestation has so far been discovered in the seed that has been brought into Texas. The occurrence of this insect in Mexico presents one of the gravest dangers which has ever confronted the cotton crop of this country, and unless the pink boll worm can be exterminated by coöperative work between the United States and Mexican authorities its ultimate infestation of the cotton fields of the Southern States is a practical certainty.

**Insecticides Purer.** That the Insecticide and Fungicide Act of 1910 has resulted in marked improvement in the quality of insecticides and fungicides entering interstate commerce is shown by the annual report of the Insecticide and Fungicide Board for the fiscal year ended June 30, 1916. Persistent sampling of four of the leading substances used in spraying shows a marked reduction in the number of violations of the act compared to preceding years. In 1915 only 8 per cent of the sam-

ples of lead arsenate taken were in violation of the act, whereas in 1911–12, 60 per cent violated the law. Similarly the violations found in lime-sulphur solutions had fallen from 94 per cent to 14 per cent, and Bordeaux mixture from 98 per cent to 36 per cent. Only 19 per cent of the shipments of Paris green examined showed any violation, whereas in 1911–12, 28 per cent of these shipments were objectionable.

While these results are probably due partly to the effect of deterrent prosecutions, they are due in even greater measure to the assistance the Department's scientists have accorded to manufacturers in making their products of standard strength and to the growing practice on the part of manufacturers of adapting themselves to improved methods and tests.

In this work during the past year, the inspectors collected 1,487 samples of different shipments. Of these, 190 were of insecticidal preparations for household use and 221 were of disinfectants, germicides, and bactericides for the prevention of diseases of human beings as well as of domestic animals. The Department during the past year has given particular attention to the prevention of the sale in interstate commerce of products recommended for household use which are either impotent or the value of which is misrepresented on labels. Many samples of arsenates, Bordeaux mixtures, sulphur, and other preparations also were taken.

In preventing the importation of misbranded or adulterated insecticides, the Insecticide and Fungicide Board collected 35 import samples. In the case of 5 preparations it was recommended that entry into this country be entirely forbidden or that the consignments be released only after being correctly labeled. In 9 other cases it was recommended that future shipments be detained. The remaining samples complied with the law.

The Board devotes considerable attention to investigational work for the determination of the value of various commercial insecticides and fungicides. It announces that it has under way tests of the merits of commercial dust and liquid sprays in the control of insects and diseases. These will include tests of articles composed of finely ground sulphur in combination with arsenate of lead, with a diluent such as finely ground lime or gypsum. The Board also is investigating the value of different commercial pyrethrum powders, tobacco powders, nicotine solutions, etc., when used as sprays, dusts or fumigants. Experiments have been made to determine the action of potassium cyanide and other substances in the control of insects and plant diseases when injected into the tissues of plants.

**New Jersey Mosquito Meeting.** The fourth annual meeting of the New Jersey Mosquito Extermination Association was held at the Hotel Traymore, Atlantic City, January 25 and 26. In point of general interest, attendance, and practical papers thoroughly covering the subject of mosquito control, this convention was perhaps the most successful ever held in the state or elsewhere. The following program was well carried out:—

"Present Status of the Mosquito Work."
By William Edgar Darnall, M. D., Atlantic City.

"The Circulation of Water on the Drained Salt Marshes—the need for and the way to obtain it."
By James E. Brooks, M. E., Glen Ridge.

"The General Principles of Salt Marsh Drainage."
By Harold I. Eaton, Atlantic City.

"The Maintenance of Salt Marsh Drainage Systems."
By William Delaney, Jersey City; John W. Dobbins, Newark; Fred A. Reilly, Atlantic City; Harry G. Van Note, Oakhurst; Stephen Johnson, Manahawkin.

"The Status of Mosquito Control Work." Symposium.
In Hudson County by Charles Lee Meyers, Jersey City.
In Bergen County by E. B. Walden, Hackensack. (Read by Mr. Howe.)
In Passaic County by Walter R. Hudson, Paterson.
In Essex County by Frederick W. Becker, M. D., Newark.
In Union County by Louis J. Richards, Elizabeth. (Read by Mr. R. W. Gies.)
In Middlesex County by Charles S. Cathcart, New Brunswick.
In Somerset County by E. F. Feickert, Plainfield.
In Mercer County by C. S. Suicerbeaux, Princeton.
In Monmouth County by William E. Warne, Keyport.
In Ocean County by Robert F. Engle, Beach Haven.
In Atlantic County by A. J. Rider, Hammonton.
In Cape May County by Joseph Camp, Pierces.
"The Essential Steps in Upland Mosquito Control."
"In Both City and Country."
By David Young, Paterson.
"In a Large City."
By Wilbur Walden, Newark.
"In the Village and Open Country."
By W. V. Becker, B. Sc., Newark.
"Salt Marsh Drainage Problems."
By C. C. Vermeule, C. E., East Orange.
"The Malaria Problem of the South."
By H. R. Carter, Assistant Surgeon General of the U. S. Public Health Service, Washington, D. C.
"The Essential Steps in Controlling the Typhoid Fly and Its Associates."
By L. O. Howard, Ph. D., M. D., Chief of the Bureau of Entomology, Washington, D. C.
"The Agricultural Utilization of the Salt Marsh."
By Jacob G. Lipman, Ph. D., Director of the New Jersey Agricultural Experiment Station, New Brunswick.
"The Place of Contract Work in Mosquito Control."
By Jesse B. Lealie, B. Sc., Hackensack.
"Publicity Methods."
By Russell W. Gies, M. Sc., Elizabeth.
"The Local Malaria Problem."
By Ulric Dahlgren, Ph. D., Princeton.
"Mosquito Control Work."
In Greater New York. By Eugene Winship, Department of Public Health of Greater New York.
In Nassau County. By C. C. Adams, Member of the Nassau County Mosquito Commission, New York City.
In Connecticut. By W. E. Britton, Ph.D., State Entomologist of Connecticut, New Haven, Conn.
In Virginia. By W. J. Schoene, State Entomologist of Virginia, Blacksburg, Va.
"The Meaning of Mosquito Extermination for the People of New Jersey—the past, the present, and the future."
By Ralph H. Hunt, M. D., East Orange.

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Harry B. Shaw, who is in charge of the New York office of the Federal Horticultural Board, was absent on leave in Bermuda for two weeks during December. While in Bermuda Mr. Shaw devoted considerable time to the study of the plant pests of the island.

# JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photo-engraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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The New York meeting like its predecessor of a decade ago was a banner gathering. The program was a full and most interesting one. It is to be regretted that there was not more time, something characteristic of a really successful gathering and a matter which could hardly be bettered under the prevailing conditions. There were some conflicts between organizations having allied or overlapping fields and this must always be expected and allowances made. There is no system by which this can be avoided unless each of the special organizations can arrange to spread their meetings over a longer period. Then there would be trouble on that score.

It is evident that the special committee appreciated the various elements involved, since it brought in a report to the effect that the organization must have sufficient time for its members to present papers and for the transaction of business. This is equally true of all and adherence to such policy simply means some conflicts, possibly annoying at times, but under the conditions prevailing, unavoidable. It is presumable that adjustments will be made as heretofore and the difficulties of members desirous of attending the sessions of several organizations minimized so far as practicable.

An important step was taken when the publication of the Index to the Literature of American Economic Entomology, 1905–1915 was authorized. This work should be in the hands of some national agency and if the general government could not undertake it, as appeared to be the case, the Association was the logical medium to handle the work.

It is to be hoped that in embracing this opportunity, we may gain strength and enter a greater field of usefulness. Efficient tools are most assuredly worth while and if they are not at hand, it certainly is worth while to pause long enough to secure the necessary equipment, be it physical apparatus, requisite training or a comprehensive index.

"I never before addressed such a distinguished audience," was the sentiment expressed by one of our members in regard to the recent meetings. These words were from a well-known entomologist whom many delight to honor. It is true that these gatherings of entomologists are assemblages of fellow-workers, but who are they? Leaders of entomological work in its manifold applications in the various states, the nation and, to a certain extent, throughout the world are to be found, as nowhere else, in this relatively small group. Some are men of affairs accustomed to mold national and state policies in matters relating to insect control. They are all eager to learn the latest developments which may be of service in their work and most of them have only a limited amount of time which can be used in this way. These facts justify care in the preparation and delivery of papers so that there should be no ground for the following from a recent communication to the editor:

> Why on earth people who have something to say which is worth hearing should not take the slight trouble to learn how to make it heard is one of the strange mysteries of modern life.
>
> A. Conan Doyle.

"The amount of mumbling and indistinct talk at the New York meetings was extremely marked, and in my opinion rendered worthless many of the papers, and a great deal of the discussion. Anyone who has anything to say which is worth saying should take pains to speak distinctly if he desires to receive credit for it."

It is not contended that these faults are peculiar to entomologists. They are human traits. Economic entomologists are mostly public men; they should speak clearly, address the audience not charts or lantern projections and prepare the paper so that it will give a comprehensive idea of the subject within the time limits. We should take a professional pride in method of presentation and delivery as well as in investigation and administration.

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D. J. Caffrey, Bureau of Entomology, reports the presence of *Toxoptera graminum* in the vicinity of Springer, N. M., and states that some of the aphids survived the recent cold snap when the temperature dropped to about zero, Fahrenheit. A recent examination showed that wingless aphids were present in the fields. A few parasitized specimens were collected during the first week in November from which adult specimens of *Aphidius testaceipes* were reared.

# Current Notes

**Conducted by the Associate Editor**

Mr. E. L. Worsham, state entomologist of Georgia, visited Washington, D. C., for a conference on December 20.

According to *Science* Mr. C. B. Williams has been appointed to study the parasites of the sugar-cane froghopper in Trinidad.

Samuel Graham and S. Marcovitch have recently been appointed research assistants in entomology at the Minnesota Agricultural Experiment Station.

The California Academy of Sciences has a new museum building at Golden Gate Park, San Francisco, which was dedicated and formally opened on September 22, 1916.

Prof. Herbert Osborn, Ohio State University, was elected vice president, Section F., of the American Association for the Advancement of Science at the recent New York meeting.

Dr. E. G. Titus has resigned as professor of Zoölogy and Entomology at the Utah Agricultural College, Logan, Utah, to take charge of seed breeding work of the U. S. Department of Agriculture.

Mr. Alvah H. Peterson, formerly of the University of Illinois, has accepted a position as assistant in entomology at the New Jersey Agricultural Experiment Station, New Brunswick, N. J.

Mr. W. W. Henderson, formerly of Brigham Young College, Logan, Utah, has been appointed professor of Zoölogy and Entomology at the Utah Agricultural College, *vice* Dr. E. G. Titus, resigned.

Prof. T. D. A. Cockerell gave the Annual Public Address before the Entomological Society of America, at the American Museum of Natural History, New York, N. Y., Wednesday evening, December 27, 1916.

Prof. H. A. Morgan, dean of agriculture in the University of Tennessee, visited Tallulah, Mound, and other points in Louisiana in company with W. D. Hunter for the purpose of reporting on the field work of the Bureau of Entomology. Visits were also made to the laboratory at New Orleans and to the Experiment Station at Baton Rouge.

Prof. Charles T. Brues is listed to give one of the free public lectures arranged by the faculty of medicine of Harvard University. These lectures will be given at the Medical School, Longwood Avenue, Cambridge, on Sunday afternoons at four o'clock. Professor Brues will speak on April 1, and his subject is "Fleas and Other Insect Parasites in their Relation to Public Health."

The following appointments have been made in the Bureau of Entomology: A. P. Sturtevant, formerly of the Massachusetts Agricultural Experiment Station, to investigate bee diseases; Harry F. Dietz and Kearn B. Brown, entomological inspectors for the Federal Horticultural Board. Mr. Dietz has been assigned to Washington, D. C., and Mr. Brown to New York.

A conference on the pine blister rust was held at Washington, January 19, at the New Willard Hotel, in connection with the meeting of the American Forestry Association. The following entomologists were present:—S. A. Forbes, Urbana, Ill.; F. L. Washburn, St. Anthony Park, Minn.; J. G. Sanders, Harrisburg, Pa.; W. J. Schoene, Blacksburg, Va.; W. C. O'Kane, Durham, N. H.

According to *Science*, Mr. E. B. Williamson has been appointed curator of Odonata in the Museum of Zoölogy, University of Michigan. He will retain his residence at Bluffton, Ind., and will direct most of the work in his department from there, making frequent trips to Ann Arbor to inspect the collections. Mr. Williamson is at present on a collecting trip in the Santa Marta Mountains, Colombia.

The annual meeting of the Brooklyn Entomological Society was held on January 13 and the following officers were elected for 1917: President, W. T. Bather; Vice-president, W. T. Davis; Treasurer, C. E. Olsen; Recording Secretary, J. R. de la Torre Bueno; Corresponding Secretary, R. P. Dow; Librarian, A. C. Weeks; Publication Committee, J. R. de la Torre Bueno, C. Schaeffer, and R. P. Dow.

In the Bureau of Entomology, R. A. Cushman, North East, Pa.; E. B. Blakeslee, Springfield, W. Va.; H. G. Ingerson, Sandusky, Ohio; John B. Gill, Monticello, Fla.; R. J. Fiske, Roswell, N. M.; E. H. Siegler, H. K. Plank, Grand Junction, Colo.; H. B. Scammell, Tom's River, N. J.; F. L. Simanton, Benton Harbor, Mich.; D. E. Fink, Norfolk, Va., have returned to Washington to examine records and prepare manuscripts.

A conference was held in the Bureau of Entomology, Washington, D. C., December 20-21 for the purpose of discussing plans for a complete resurvey of the Hessian fly problem throughout the wheat-growing regions of the United States. The following entomologists were in attendance: Dr. L. O. Howard, Prof. S. A. Forbes, Dr. A. D. Hopkins, Dr. A. L. Quaintance, and Messrs. W. P. Flint, E. O. G. Kelly, G. G. Ainslee, W. R. McConnell, J. J. Davis, J. A. Hyslop, G. I. Reeves, and W. R. Walton.

The following entomological workers have resigned from the Bureau of Entomology: —W. H. Larrimer, formerly in charge of the field laboratory at Charleston, Mo., to accept a position in the Forest Service; R. N. Wilson, formerly in charge of the field laboratory at Gainesville, Fla., to accept a position as county agent, Palm Beach County, Fla.; H. K. Laramore, in charge of field station, Plymouth, Ind., F. M. Wadley, field assistant, Wichita, Kansas, E. S. Tucker, temporary field assistant, Baton Rouge, La., appointments terminated.

According to *Experiment Station Record*, Prof. J. A. Portchinsky, the distinguished Russian entomologist, died May 21, 1916, at the age of sixty-eight years. From 1874 to 1894, Professor Portchinsky was scientific secretary to the Russian Entomological Society, and since 1894 chief of the entomological bureau of the Ministry of Agriculture and chief editor of its memoirs. He was the author of twenty-four memoirs, besides a large number of other scientific contributions. He was also the Russian reviewer of the *Review of Applied Entomology*. He had traveled extensively over Russia, Caucasia, and Turkestan, and collected a mass of materials on the biology of insects.

The following changes and transfers have been made in the Bureau of Entomology: —A. F. Satterthwait, formerly of the West Lafayette (Ind.) laboratory, has been detailed to take charge of the Charleston (Mo.) Station; R. L. Nougaret, Walnut Creek, to Fresno, Cal.; W. M. Davidson to Sacramento, Cal.; A. H. McCray from apicultural investigations to work on insects affecting the health of man, stationed at New Orleans, La. The name of the Forest Tree Seed Insect Station, Ashland, Ore., has been changed to Pacific Slope Station, with J. M. Miller in charge; the station at Placerville, Cal., formerly called Pacific Slope Station, has been moved to Los Gatos, Cal., and will now be known as Forest Insect Laboratory, with H. E. Burke in charge.

The fifty-third annual meeting of the Ontario Entomological Society was held at the Ontario Agricultural College, Guelph, November 2 and 3, 1916. Dr. L. O. Howard, Washington, D. C., and Prof. P J. Parrott, Geneva, N. Y., were present from the United States, and Doctor Howard gave an evening lecture on "The Carriage of Diseases by Insects," which was illustrated with lantern slides. The following officers were elected for the coming year:—President Albert F. Winn, Westmont, Que.; Vice-President, Lawson Caesar, Guelph; Secretary-Treasurer, A. W. Baker, Guelph; Curator, W. Evans, Guelph; Librarian, C. J. S. Bethune, Guelph; Directors, Arthur Gibson, Ottawa; C. E. Grant, Orillia; A. Cosens, Toronto; F. J. A. Morris, Peterborough; J. W. Noble, Essex; W. A. Ross, Vineland Station; Delegate to the Royal Society of Canada, F. J. A. Morris, Peterborough.

Mr. Otto Heidemann, long connected with the Bureau of Entomology and custodian of the Hemiptera in the National Museum, died after an operation, on the morning of November 18 at the Homeopathic Hospital in Washington. Mr. Heidemann originally came to the Department in 1883 and for a number of years was employed as a wood engraver. With the development of photo-engraving his occupation was lost, and in 1893 he began for the first time the study of insects. It is an unusual thing for a man well beyond fifty to take up *de novo* the occupation which he is to follow ardently for the rest of his life. Mr. Heidemann became known all over the world as an authority on the group of insects which he studied. His address as retiring President of the Entomological Society of Washington on the eggs of Hemiptera was a paper of striking merit. He leaves a widow, Mrs. Mica Heidemann, well known as a sculptress and as a maker of insect models. [L. O. HOWARD.]

During the summer of 1916 a successful demonstration in anti-mosquito work was carried out in Minneapolis by the Minneapolis Real Estate Board. Ten square miles in South Minneapolis were chosen for the demonstration, an area typical of local conditions and of more than average difficulty. C. W. Howard of the Division of Economic Zoölogy of the University of Minnesota was placed in charge and six University students engaged for the work. The mosquitos mostly concerned were *Culex pipiens*, *Aëdes sylvestris*, *Aëdes canadensis*, *Culex restuans*, and *Culex tarsalis*, but especially the first two. In spite of the many large stretches of swamp and dumping areas, the mosquitos were reduced fully 99 per cent. So marked were the results that there has been a large demand for the continuation of the work next year under the same direction. The City Health Department will probably coöperate and the entire city will be covered. House-fly elimination will be included with the mosquito work. At least thirty-five men will be needed as inspectors. —University Farm, St. Paul, Minnesota, December 4, 1916.

At the recent annual meeting of the Entomological Society of America, held in New York, the following officers were elected:—President, Lawrence Bruner, Lincoln, Neb.; First Vice-President, E. M. Walker, Toronto, Ont.; Second Vice-President, H. C. Fall, Pasadena, Cal.; Secretary-Treasurer, J. M. Aldrich, West Lafayette, Ind.; Managing Editor of *Annals*, Herbert Osborn, Ohio State University, Columbus, Ohio; Executive Committee, the officers and E. B. Williamson, Bluffton, Ind.; A. D. Hopkins, Washington, D. C.; W. J. Holland, Pittsburgh, Pa.; E. D. Ball, Madison, Wis., and C. W. Johnson, Boston, Mass. The following were elected to the Editorial Board: T. D. A. Cockerell, Boulder, Colo.; William A. Riley, Ithaca, N. Y.; L. O. Howard, Washington, D. C.; P. P. Calvert, Philadelphia, Pa.; J. H. Emerton, Boston, Mass.; C. Gordon Hewitt, Ottawa, Ont.; Lawrence Bruner, Lincoln, Neb.; J. W. Folsom, Urbana, Ill.; and H. C. Fall, Pasadena, Cal. The Committee of the Thomas Say Foundation consists of the following: Nathan Banks, Cambridge, Mass.; A. D. McGillivray, Urbana, Ill.; Morgan Hebard, Philadelphia, Pa.; E. B. Williamson, Bluffton, Ind.; J. M. Aldrich, editor, West Lafayette, Ind.; E. D. Ball, treasurer, Capitol Bldg., Madison, Wis.

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